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function analyse_errors_bins(pos_estimated,score,pos, endbulges)
%analyse_errors_bins(pos_estimated,score,pos, endbulges)
% measure the distribution of erros
if length(pos_estimated) ~= length(score)
    error('pos_estimated and score not compatible');
end
if length(pos_estimated) ~= length(pos)
    error('pos_estimated and pos not compatible');
end
if length(pos_estimated) ~= length(endbulges)
    error('pos_estimated and endbulges size not compatible');
end
N = 100;
Per_bin = 20;
mxscore = max(score);
mnscore = min(score);
dth = (mxscore- mnscore)/N;
thresh = mnscore:dth:mxscore;
accuracy = zeros(0);
correct_side_dist1 = zeros(0); %correct size, distance = 1;
correct_side_dist2 = zeros(0);
correct_side_dsth = zeros(0);
wrong_side = zeros(0);
fraction = zeros(0);
count = 0;
N = length(pos);
for i = 1:length(endbulges)
    eb = find(endbulges{i});
    correct_side(i) = 0.5*( 1 + sign((pos_estimated(i) - eb(1))*(pos(i) -eb(1))))); %one for correct side estimate
end
for i = 1:length(thresh)-Per_bin
    I = find(score >= thresh(i) & score <= thresh(i+Per_bin));
    if ~isempty(I)
        count = count + 1;
        midbin(count) = 0.5*(thresh(i) + thresh(i+Per_bin));
        accuracy(count) = sum(pos_estimated(I) == pos(I))/length(I);

        J1 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 1);
        correct_side_dist1(count) = length(J1)/length(I);
        J2 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 2);
        correct_side_dist2(count) = length(J2)/length(I);
        Jh = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) > 2);
        correct_side_dsth(count) = length(Jh)/length(I);

        wrong_side(count) = sum(1-correct_side(I))/length(I);

        fraction(count) = length(I)/N;
    else
        count = count+1;
    end
end

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midbin(count) = 0.25*(thresh(i) + 2* thresh(i+1) + thresh(i+2));
accuracy(count) = NaN;
correct_side_dist1(count) = NaN;
correct_side_dist2(count) = NaN;
correct_side_dsth(count) = NaN;
wrong_side(count) = NaN;
fraction(count) = NaN;
end
end

acc1 = accuracy + correct_side_dist1;
acc2 = accuracy + correct_side_dist1 + correct_side_dist2;
clf
hold on

plot(midbin, acc2,'g')
plot(midbin, acc1,'r')
plot(midbin, accuracy,'b')
plot(midbin, wrong_side,'k')
plot(midbin,fraction,'c')

legend('dist \leq 2', 'dist \leq 1', 'precise', 'wrong side');
plot(midbin, acc2,'*g')
plot(midbin, acc1,'or')
plot(midbin, accuracy,'bd')
plot(midbin, wrong_side,'kv')
xlabel('bin');
%keyboard
returnfunction analyse_errors_bins1(pos_estimated,score,pos, endbulges,N)
%analyse_errors_bins1(pos_estimated,score,pos, endbulges)
% measure the distribution of erros
if length(pos_estimated) ~= length(score)
    error('pos_estimated and score not compatible');
end
if length(pos_estimated) ~= length(pos)
    error('pos_estimated and pos not compatible');
end
if length(pos_estimated) ~= length(endbulges)
    error('pos_estimated and endbulges size not compatible');
end
if nargin == 4
    N = 6;
end
perc = [1:-1/N:0]*100;
thresh = prctile(score, perc);
accuracy = zeros(0);
correct_side_dist1 = zeros(0); %correct size, distance = 1;
correct_side_dist2 = zeros(0);
correct_side_dsth = zeros(0);
wrong_side = zeros(0);

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fraction = zeros(0);
count = 0;
N = length(pos);
for i = 1:length(endbulges)
    eb = find(endbulges{i});
    correct_side(i) = 0.5*( 1 + sign((pos_estimated(i) - eb(1))*(pos(i) -eb(1)))); %one for correct side estimate
end
for i = 1:length(thresh)-1
    I = find(score <= thresh(i) & score >= thresh(i+1));
    if ~isempty(I)
        count = count + 1;
        midbin(count) = mean(score(I));
        accuracy(count) = sum(pos_estimated(I) == pos(I))/length(I);

        J1 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 1);
        correct_side_dist1(count) = length(J1)/length(I);
        J2 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 2);
        correct_side_dist2(count) = length(J2)/length(I);
        Jh = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) > 2);
        correct_side_disth(count) = length(Jh)/length(I);

        wrong_side(count) = sum(1-correct_side(I))/length(I);

        fraction(count) = length(I)/N;
    else
        count = count+1;
        midbin(count) = NaN;;
        accuracy(count) = NaN;
        correct_side_dist1(count) = NaN;
        correct_side_dist2(count) = NaN;
        correct_side_disth(count) = NaN;
        wrong_side(count) = NaN;
        fraction(count) = NaN;
    end
end

acc1 = accuracy + correct_side_dist1;
acc2 = accuracy + correct_side_dist1 + correct_side_dist2;
clf
hold on

plot(midbin, acc2,'g')
plot(midbin, acc1,'r')
plot(midbin, accuracy,'b')
plot(midbin, wrong_side,'k')
plot(midbin,fraction,'c')

legend('dist \leq 2', 'dist \leq 1', 'precise', 'wrong side');
plot(midbin, acc2,'*g')

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plot(midbin, acc1,'or')
plot(midbin, accuracy,'bd')
plot(midbin, wrong_side,'kv')
xlabel('bin');
%keyboard
returnfunction analyse_errors_perc(pos_estimated,score,pos, endbulges)
%analyse_errors_perc(pos_estimated,score,pos, endbulges)
% measure the distribution of erros
N = 100;
perc = [1:-1/N:0]*100;
thresh = prctile(score, perc);
accuracy = zeros(0);
correct_side_dist1 = zeros(0); %correct size, distance = 1;
correct_side_dist2 = zeros(0);
correct_side_dsth = zeros(0);
wrong_side = zeros(0);
fraction = zeros(0);
count = 0;
N = length(pos);
for i = 1:length(endbulges)
    eb = find(endbulges{i});
    correct_side(i) = 0.5*( 1 + sign((pos_estimated(i) - eb(1))*(pos(i) -eb(1))))); %one for correct side estimate
end
for i = 1:length(thresh)
    I = find(score > thresh(i));
    if ~isempty(I)
        count = count + 1;
        accuracy(count) = sum(pos_estimated(I) == pos(I))/length(I);

        J1 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 1);
        correct_side_dist1(count) = length(J1)/length(I);
        J2 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 2);
        correct_side_dist2(count) = length(J2)/length(I);
        Jh = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) > 2);
        correct_side_dsth(count) = length(Jh)/length(I);

        wrong_side(count) = sum(1-correct_side(I))/length(I);

        fraction(count) = length(I)/N;
    else
        count = count+1;
        accuracy(count) = NaN;
        correct_side_dist1(count) = NaN;
        correct_side_dist2(count) = NaN;
        correct_side_dsth(count) = NaN;
        wrong_side(count) = NaN;
        fraction(count) = NaN;
    end
end
end

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acc1 = accuracy + correct_side_dist1;
acc2 = accuracy + correct_side_dist1 + correct_side_dist2;
clf
hold on

plot(perc, acc2,'g')
plot(perc, acc1,'r')
plot(perc, accuracy,'b')
plot(perc, wrong_side,'k')
plot(perc, thresh,'c')
legend('dist \leq 2', 'dist \leq 1', 'precise', 'wrong side', 'threshold');
xlabel('percentage');
axis([0 100 0 1]);
%keyboard
returnfunction analyse_errors_thresh(pos_estimated,score,pos, endbulges)
%analyse_errors_thresh(pos_estimated,score,pos, endbulges)
% measure the distribution of erros
if max(score) > 1
    mxscore = max(score);
else
    mxscore = 1;
end
if min(score) < 0
    mnscore = min(score);
else
    mnscore = 0;
end
Np = 500;
dth = (mxscore- mnscore)/Np;
thresh = mnscore:dth:mxscore;
accuracy = zeros(0);
correct_side_dist1 = zeros(0); %correct size, distance = 1;
correct_side_dist2 = zeros(0);
correct_side_disth = zeros(0);
wrong_side = zeros(0);
fraction = zeros(0);
count = 0;
N = length(pos);
for i = 1:length(endbulges)
    eb = find(endbulges{i});
    correct_side(i) = 0.5*( 1 + sign((pos_estimated(i) - eb(1))*(pos(i) -eb(1))))); %one for correct side estimate
end
for i = 1:length(thresh)
    l = find(score > thresh(i));
    if ~isempty(l)
        count = count + 1;
        accuracy(count) = sum(pos_estimated(l) == pos(l))/length(l);

        J1 = find(correct_side(l) & abs(pos(l)- pos_estimated(l)) == 1);
    end
end

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correct_side_dist1(count) = length(J1)/length(I);
J2 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 2);
correct_side_dist2(count) = length(J2)/length(I);
Jh = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) > 2);
correct_side_disth(count) = length(Jh)/length(I);

wrong_side(count) = sum(1-correct_side(I))/length(I);

fraction(count) = length(I)/N;
else
    count = count+1;
    accuracy(count) = NaN;
    correct_side_dist1(count) = NaN;
    correct_side_dist2(count) = NaN;
    correct_side_disth(count) = NaN;
    wrong_side(count) = NaN;
    fraction(count) = NaN;
end
end

acc1 = accuracy + correct_side_dist1;
acc2 = accuracy + correct_side_dist1 + correct_side_dist2;
clf
hold on

plot(thresh, acc2,'g')
plot(thresh, acc1,'r')
plot(thresh, accuracy,'b')
plot(thresh, wrong_side,'k')
plot(thresh, fraction,'c')
legend('dist \leq 2', 'dist \leq 1', 'precise', 'wrong side', 'fraction');
xlabel('threshold');
%keyboard
returnfunction y = edit_distance(s,t)
% y = edit_distance(s,t)
% compute edit (levenstein) distance between s and t
C = 0.5; % parameter that fixes the relative
%Algorithm
%
%Construct a matrix containing 0..m rows and 0..n columns.
% Initialize the first row to 0..n.
% Initialize the first column to 0..m.
% 3. Examine each character of s (i from 1 to n).
% 4. Examine each character of t (j from 1 to m).
% 5. If s[i] equals t[j], the cost is 0.
%6. If s[i] doesn't equal t[j], the cost is 1.
% Set cell d[i,j] of the matrix equal to the minimum of:
%a. The cell immediately above plus 1: d[i-1,j] + 1.
%b. The cell immediately to the left plus 1: d[i,j-1] + 1.

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%c. The cell diagonally above and to the left plus the cost: d[i-1,j-1] + cost.
%7 After the iteration steps (3, 4, 5, 6) are complete, the distance is found in cell d[n,m]
n = length(s);
m = length(t);
if n == 0
    y = m;
    return;
end
if m == 0
    y = n;
    return;
end
d = zeros(n+1,m+1); %Construct a matrix containing 0..m rows and 0..n columns.
d(1,:) = [0:m];      % Initialize the first row to 0..n.
d(:,1) = [0:n]';     %Initialize the first column to 0..m.
for i = 1:n
    for j = 1:m
        cost = (s(i) ~= t(j));
        d(i+1,j+1) = min([d(i+1,j)+1, d(i,j+1)+1, d(i,j)+cost]);
    end
end
y = d(n+1,m+1);
return

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function [pos,score] = edit_predict(seqsd, seqs, endbulges)
% y = edit_predict(seqsd, seqs, endbulges)
% find the best matching dicer position by its edit distance to one of the existing dicers
%
% GD 20.2
global Min_dlength Alpha Step
paramfile = 'edit_params';
%addpath('d:/matlab'); % whereabouts of edit_distance
disp('calculating...');
Step = 1;
fid = fopen(paramfile,'r');
while ~feof(fid)
    line = fgetl(fid);
    eval(line)
end
fclose(fid);
for i = 1:length(seqs)
    %disp(num2str(i));
    [posi, scorei] = edit_predict1(seqsd,seqs{i}, endbulges{i});
    pos(i) = posi;
    score(i) = scorei;
end
return
function [pos, score] = edit_predict1(seqsd,seqsi, endbulgesi);
%calculate the best matching position of dicer
global Min_dlength Alpha Step

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seq_size = length(seqsi);
lb = find(endbulgesi);
eb_size = length(lb);
eb_begin = lb(1);
eb_end = lb(eb_size);
nd = length(seqsd); % number of known dicers
length_seqi = length(seqsi);
%initialize variables with the largest possible distance
min_d = ones(length_seqi,1)*Min_dlength;
mean_d = ones(length_seqi,1)*Min_dlength;
%upper side
for i = eb_begin-Min_dlength:-Step:1
    p = seqsi(i:i+Min_dlength-1);
    for j = 1:length(seqsd)
        % d(j) = edit_distance(p,seqsd{j});
        d(j) = editD(p,seqsd{j});
    %    d(j) = editD(p,seqsd{j});
    end
    min_d(i) = min(d);
    % take also the mean of highest percentile
    [ds,I] = sort(d);
    mean_d(i) = mean(ds(1:floor(Alpha*nd)));
end
for i = eb_end+1:Step:length(seqsi)-Min_dlength+1
    p = seqsi(i:i+Min_dlength-1);
    for j = 1:length(seqsd)
        d(j) = editD(p,seqsd{j});
    end
    min_d(i) = min(d);
    % take also the mean of highest ten percentile
    [ds,I] = sort(d);
    mean_d(i) = mean(ds(1:floor(Alpha*nd)));
end
mmn = min(min_d);
I = find(min_d == mmn);
if length(I) == 1
    pos = I;
    score = Min_dlength - mmn;
else
    % take the position with hte highest alpha score
    [mn,J] = min(mean_d(I));
    pos = I(J);
    score = Min_dlength - mmn;
end
return
function [pos,score] = edit_predictk(seqsd, seqs, endbulges, k, thresh)
% y = edit_predictk(seqsd, seqs, endbulges, k, thresh);
% find the best matching dicer position by its edit distance to one of the existing dicers
% criterion is mean among best k matches
%thresh is the

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% GD 20.2
global Min_dlength Step
paramfile = 'edit_params';
addpath('d:/matlab'); % whereabouts of edit_distance
if nargin <= 4
    thresh = 1.1;
end
if length(seqs) ~= length(endbulges)
    error('size of seqs and endbulges not compatible');
end
if thresh < 1
    error('thresh must be < 1');
end
Step = 1;
fid = fopen(paramfile,'r');
while ~feof(fid)
    line = fgetl(fid);
    eval(line)
end
fclose(fid);
for i = 1:length(seqs)
    disp(num2str(i));
    [posi, scorei] = edit_predict1(seqsd,seqs{i}, endbulges{i},k,thresh);
    pos(i) = posi;
    score(i) = scorei;
end
return
function [pos, score] = edit_predict1(seqsd,seqsi, endbulgesi,k,thresh);
%calculate the best matching position of dicer
global Min_dlength Step
seq_size = length(seqsi);
lb = find(endbulgesi);
eb_size = length(lb);
eb_begin = lb(1);
eb_end = lb(eb_size);
nd = length(seqsd); % number of known dicers
length_seqi = length(seqsi);
%initialize variables with the largest possible distance
min_d = ones(length_seqi,1)*Min_dlength;
mean_d = ones(length_seqi,1)*Min_dlength;
%upper side
for i = eb_begin-Min_dlength:-Step:1
    p = seqsi(i:i+Min_dlength-1);
    for j = 1:length(seqsd)
        d(j) = edit_distance(p,seqsd{j});
    end
    % take also the mean of best k
    [ds,l] = sort(d);
    mean_d(i) = mean(ds(1:k));
end
end

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%lower side
for i = eb_end+1:Step:length(seqsi)-Min_dlength+1
    p = seqsi(i:i+Min_dlength-1);
    for j = 1:length(seqsd)
        d(j) = edit_distance(p,seqsd{j});
    end
    [ds,l] = sort(d);
    mean_d(i) = mean(ds(1:k));
end
mmn = min(mean_d);
l = find(mean_d <= thresh* mmn);
if length(l) ==1
    pos = l;
    score = Min_dlength - mmn;
else
    % take the position closest to loop
    side = sign(l - eb_begin);
    loopdist = 0.5*(1-side).* (eb_begin - l - Min_dlength) + 0.5*(1+side).*(l- eb_end-1);
    [mndist,J] = min(loopdist);
    l = l(J);
    pos = l;
    score = Min_dlength - mean_d(l);
end
return
function [si,sj] = find_identical_pairs(seqs)
%[si,sj] = find_identical_pairs(seqs)
% find identical palindromes in list
L = length(seqs);
for i = 1:L
    lenp(i) = length(seqs{i});
end
[lenps, l] = sort(lenp);
seqs = seqs(l);
count = 0;
for i = 1:L
    for j = i+1:L
        if lenps(i) ~= lenps(j)
            break
        else
            if all(seqs{i} == seqs{j})
                count = count+1;
                si(count) = l(i);
                sj(count) = l(j);
            end
        end
    end
end
end
end

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function strseq = int2nuc(intseq, ncase)
%strseq = int2nuc(intseq, ncase)

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%convert a sequence of '1 2 3 4' into 'A C T G' or 'a c t g'
% ncase = uppercase | lowercase
if nargin == 1
    ncase = 'uppercase';
end
if strcmp(ncase,'uppercase')
    nucs = 'ACTG';
elseif strcmp(ncase,'lowercase')
    nucs = 'actg';
end
strseq = char(size(intseq));
for i = 1:length(intseq)
    strseq(i) = nucs(intseq(i));
end
return
method = 'poly3'
if method == 'poly2'
% poly2 combined
    %configuration: 5' -2 7 -2 6 3' -11 0 -11 0
    %points on side error line
    as = [-1.5000 -0.9988 -0.5012 -0.0035 0.5012 0.99 1.4927];
    bs = [0.2325 0.2295 0.1360 0.0804 0.0336 0.0102 0.0015];
    %points on precise within2 line
    ap = [-1.4965 -0.9988 -0.5012 0.0035 0.5012 0.9988];
    bp = [0.6798 0.6974 0.8348 0.9196 0.9722 0.9985];
elseif method == 'poly3'
    % configuration: 5' -2 7 -2 6 3' -11 0 -11 0
    % alpha5 = 0.9; alpha3 = 0.40; alpha_dlen = 0.2;
    %points on side error line
    as = [-1.4981 -1.2412 -0.9994 -0.5006 0.0019 0.5044 0.7727 0.9994 1.2714 1.5057];
    bs = [0.2303 0.2248 0.2028 0.1239 0.0872 0.0560 0.0211 0.0211 0 0];
    %points on precise within2 line
    ap = [-1.4981 -1.3281 -1.0031 -0.4931 0.0019 0.4969 0.9994 1.5000];
    bp = [0.6940 0.7000 0.7312 0.8688 0.9165 0.9404 0.9752 1.0000
yside = 1-interp1(as,bs,xi,'linear','extrap')
yprec = interp1(ap,bp,xi,'linear','extrap')
function [yside, yprec2] = interpolate_prob_new(score, fitfile);
%[yside, yprec2] = interpolate_prob_new(score, fitfile);
% load the parameters for interpolation
fid = fopen(fitfile,'r');
while ~feof(fid)
    line = fgetl(fid);
    if ~isstr(line), break , end;
    eval(line)
end
fclose(fid);
%interpolate
yside = interp1(xs,ys,score,'linear');
yprec2 = interp1(xp2,yp2,score,'linear');
returnfunction [yside, yprec2] = interpolate_prob_old_ver5(xi, method);

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%[yside, yprec2] = interpolate_prob_old_ver5(yi, method);
% parameters are configuration specific see below!
disp('these are the accumulated performance, not the actual performance per bin');
disp(' press enter to continue');
pause
if nargin == 1
    method = 'poly3';
end
if strcmp(method, 'poly2')
% poly2 combined
    %configuration: 5' -2 7 -2 6 3' -11 0 -11 0
    %points on side error line
    as = [-1.5000 -0.9988 -0.5012 -0.0035 0.5012 0.99 1.4927];
    bs = [0.2325 0.2295 0.1360 0.0804 0.0336 0.0102 0.0015];
%points on precise within2 line
    ap = [-1.4965 -0.9988 -0.5012 0.0035 0.5012 0.9988];
    bp = [0.6798 0.6974 0.8348 0.9196 0.9722 0.9985];
elseif strcmp(method, 'poly3')
    % configuration: 5' -2 7 -2 6 3' -11 0 -11 0
    % alpha5 = 0.9; alpha3 = 0.40; alpha_dlen = 0.2;
    %points on side error line
    as = [-1.4981 -1.2412 -0.9994 -0.5006 0.0019 0.5044 0.7727 0.9994 1.2714 1.5057];
    bs = [0.2303 0.2248 0.2028 0.1239 0.0872 0.0560 0.0211 0.0211 0 0];
    %points on precise within2 line
    ap = [-1.4981 -1.3281 -1.0031 -0.4931 0.0019 0.4969 0.9994 1.5000];
    bp = [0.6940 0.7000 0.7312 0.8688 0.9165 0.9404 0.9752 1.0000];
end
yside = 1-interp1(as,bs,xi,'linear');
yprec2 = interp1(ap,bp,xi,'linear');
function [yside, yprec2] = interpolate_probabilities(xi, method);
%[yside, yprec2] = interpolate_probabilities(yi, method);
% parameters are configuration specific see below!
if nargin == 1
    method = 'poly3';
end
if strcmp(method, 'poly3')
    % configuration: 5' -2 7 -2 6 3' -11 0 -11 0
    % alpha5 = 0.9; alpha3 = 0.40; alpha_dlen = 0.2;
    %points on side error line
    as = [1.5000 1.3235 1.2591 0.9478 0.2052 -0.1707 -0.3337 -0.5573 -0.7706 -1.0873];
    bs = [1.0000 1.0000 0.9355 0.8710 0.8485 0.8438 0.8182 0.5806 0.5000 0.5000];
    ap = as;
    bp = [1.0000 1.0000 0.9355 0.8710 0.8485 0.8438 0.7576 0.4839 0.2803 0.2681];
end
yside = 1-interp1(as,bs,xi,'linear','extrap');
yprec2 = interp1(ap,bp,xi,'linear','extrap');
function [yside, yprec2] = interpolate_probabilities_ver5(xi, method);
%[yside, yprec2] = interpolate_probabilities_ver5(yi, method);
% parameters are configuration specific see below!
disp('these are the accumulated performance, not the actual performance per bin');

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```

disp(' press enter to continue');
pause
if nargin == 1
    method = 'poly3';
end
if strcmp(method, 'poly2')
% poly2 combined
    %configuration: 5' -2 7 -2 6 3' -11 0 -11 0
    %points on side error line
    as = [-1.5000 -0.9988 -0.5012 -0.0035 0.5012 0.99 1.4927];
    bs = [0.2325 0.2295 0.1360 0.0804 0.0336 0.0102 0.0015];
%points on precise within2 line
    ap = [-1.4965 -0.9988 -0.5012 0.0035 0.5012 0.9988];
    bp = [0.6798 0.6974 0.8348 0.9196 0.9722 0.9985];
elseif strcmp(method, 'poly3')
    % configuration: 5' -2 7 -2 6 3' -11 0 -11 0
    % alpha5 = 0.9; alpha3 = 0.40; alpha_dlen = 0.2;
    %points on side error line
    as = [-1.4981 -1.2412 -0.9994 -0.5006 0.0019 0.5044 0.7727 0.9994 1.2714 1.5057];
    bs = [0.2303 0.2248 0.2028 0.1239 0.0872 0.0560 0.0211 0.0211 0 0];
    %points on precise within2 line
    ap = [-1.4981 -1.3281 -1.0031 -0.4931 0.0019 0.4969 0.9994 1.5000];
    bp = [0.6940 0.7000 0.7312 0.8688 0.9165 0.9404 0.9752 1.0000];
end
yside = 1-interp1(as,bs,xi,'linear');
yprec2 = interp1(ap,bp,xi,'linear');
function [yside, yprec2] = interpolate_probabilities_ver5(xi, method);
%[yside, yprec2] = interpolate_probabilities_ver5(yi, method);
% parameters are configuration specific see below!
disp('these are the accumulated performance, not the actual performance per bin');
disp(' press enter to continue');
pause
if nargin == 1
    method = 'poly3';
end
if strcmp(method, 'poly2')
% poly2 combined
    %configuration: 5' -2 7 -2 6 3' -11 0 -11 0
    %points on side error line
    as = [-1.5000 -0.9988 -0.5012 -0.0035 0.5012 0.99 1.4927];
    bs = [0.2325 0.2295 0.1360 0.0804 0.0336 0.0102 0.0015];
%points on precise within2 line
    ap = [-1.4965 -0.9988 -0.5012 0.0035 0.5012 0.9988];
    bp = [0.6798 0.6974 0.8348 0.9196 0.9722 0.9985];
elseif strcmp(method, 'poly3')
    % configuration: 5' -2 7 -2 6 3' -11 0 -11 0
    % alpha5 = 0.9; alpha3 = 0.40; alpha_dlen = 0.2;
    %points on side error line
    as = [-1.4981 -1.2412 -0.9994 -0.5006 0.0019 0.5044 0.7727 0.9994 1.2714 1.5057];
    bs = [0.2303 0.2248 0.2028 0.1239 0.0872 0.0560 0.0211 0.0211 0 0];

```

```

%points on precise within2 line
ap = [-1.4981 -1.3281 -1.0031 -0.4931 0.0019 0.4969 0.9994 1.5000];
bp = [0.6940 0.7000 0.7312 0.8688 0.9165 0.9404 0.9752 1.0000];
end
yside = 1-interp1(as,bs,xi,'linear');
yprec2 = interp1(ap,bp,xi,'linear');
function [yside, yprec2] = interpolate_probabilities_ver5(xi, method);
%[yside, yprec2] = interpolate_probabilities_ver5(yi, method);
% parameters are configuration specific see below!
disp('version 5 does not allow for extrapolation')
if nargin == 1
    method = 'poly3';
end
if strcmp(method,'poly3')
    % configuration: 5' -2 7 -2 6 3' -11 0 -11 0
    % alpha5 = 0.9; alpha3 = 0.40; alpha_dlen = 0.2;
    %points on side error line
    as = [1.5000 1.3235 1.2591 0.9478 0.2052 -0.1707 -0.3337 -0.5573 -0.7706 -1.0873];
    bs = [1.0000 1.0000 0.9355 0.8710 0.8485 0.8438 0.8182 0.5806 0.5000 0.5000];
    ap = as;
    bp = [1.0000 1.0000 0.9355 0.8710 0.8485 0.8438 0.7576 0.4839 0.2803 0.2681];
end
%yside = 1-interp1(as,bs,xi,'linear','extrap');
%yprec2 = interp1(ap,bp,xi,'linear','extrap');
yside = 1-interp1(as,bs,xi,'linear');
yprec2 = interp1(ap,bp,xi,'linear');
function len = length_seq(seqs);
%len = length_seq(seqs);
%calculate sequence length
for i = 1:length(seqs)
    len(i) = length(seqs{i});
end
returnl = find(lenp-pos >= 22);
for i = 1:length(l)
    frstl(i) = seqs{l(i)}(pos(l(i)));
    lastl(i,:) = seqs{l(i)}([20+pos(l(i)), 21+pos(l(i))]);
end %load training data
randomize = 1;
curdir = pwd;
cd d:/rosetta/data_new
load matlab_147_unique.mat
if randomize
    disp('performing randomized permutation');
    l = randperm(length(seqs));
    bulges1 = bulges1(l);
    bulges2 = bulges2(l);
    endbulges = endbulges(l);
    lend = lend(l);
    lenp = lenp(l);
    pos = pos(l);

```

```

seq_id = seq_id(l);
seqs = seqs(l);
seqsd = seqsd(l);
end
cd(curdir) %load training data
randomize = 0;
curdir = pwd;
cd d:/rosetta/data_new
load matlab_147_unique.mat
if randomize
disp('performing randomized permutation');
l = randperm(length(seqs));
bulges1 = bulges1(l);
bulges2 = bulges2(l);
endbulges = endbulges(l);
lend = lend(l);
lenp = lenp(l);
pos = pos(l);
seq_id = seq_id(l);
seqs = seqs(l);
seqsd = seqsd(l);
end
cd(curdir) %load training data
curdir = pwd;
cd d:/rosetta/data_new
load matlab_173_unique.mat
cd(curdir) function pos = locate_dicer(dicer_seq,pal_seq);
%pos = locate_dicer(dicer_seq,palseq)
%get absolute position of dicer on palindrom, from the beginning of the plindrom
if length(dicer_seq) ~= length(pal_seq)
error('different number of sequences');
end
pos = zeros(1,length(dicer_seq));
for i = 1:length(dicer_seq)
l = findstr(dicer_seq{i}, pal_seq{i});
if length(l) == 1
pos(i) = l;
else
pos(i) = NaN;
end
end
end
function pos_dummy = make_pos_dummy(seqs,bulges1,bulges2,endbulges)
%pos_dummy = make_pos_dummy(seqs,bulges1,bulges2,endbulges)
% construct dummy pos vector for testing classifiers
global Nnucfrom Nnucto Nbfrom Nbto mode
global Min_dlength
mode = 'testing'
[Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength] = read_params('params5.dat');
pos_dummy = zeros(1, length(seqs));
for i = 1:length(seqs)

```

```

    pos_dummy(i) = mkpsi0(seqs{i},bulges1{i},bulges2{i},endbulges{i});
    %pos_dummy(i) = mkpsi1(seqs{i},bulges1{i},bulges2{i},endbulges{i});
end
return
% version 0
function posi = mkpsi0(seqs, bulges1i, bulges2i, endbulgesi)
global Nnucfrom Nnucto Nbfrom Nbto mode
global Min_dlength
% simple rule
% assume dicer of length 17 exactly.
% nearest , in euclidean distance to some prototype, regardless of distance
% from loop and side
% params are assumed -2 3 -2 7
prototype = [0.3381,-0.4804,0.1813,-0.1205,0.3318,0.0028,0.2095,-0.3635, ...
-0.0711,-0.1954,-0.3103,-0.3066,0.1822,-0.1972,0.0417,0.3385,-0.4882, ...
-0.3491,0.1979,-0.1216,0.3600,0.3537,0.0936,0.2271,-0.1907,0.3939, ...
0.3385,0.0681,-0.1296,0.2027,0.0466,0.2948,0.4568,0.0226,0.0182,...
0.0828,-0.0765,0.0155,-0.1660,-0.0671,-0.2741,0.0798,-0.3252,0.0678 ...
0.2604,0.0298,0.1405,-0.2909,-0.1202,0.2833,0.1808,-0.4104,-0.0389];
seq_size = length(seqs);
lb = find(endbulgesi);
eb_size = length(lb);
eb_begin = lb(1);
[xi, yi] = preprocess5(seqs, bulges1i, bulges2i, endbulgesi);
[m,n] = size(xi);
sim = xi(:,3:n)*(prototype(1:n-2))';
[maxs,m] = max(sim);
side = xi(m,1);
loopdist = xi(m,2) * (0.5* (seq_size - eb_size));
posi = (1+side)/2*(eb_end + loopdist) + (1-side)/2*(eb_begin - loopdist);
return
% version 1
function posi = mkpsi1(seqs, bulges1i, bulges2i, endbulgesi)
% simple rule
% assume dicer of length 17 exactly.
% nearest position to loop, such that dicer begins with t , not on bulge1
global Nnucfrom Nnucto Nbfrom Nbto mode
global Min_dlength
lb = find(endbulgesi);
eb_size = length(lb);
eb_begin = lb(1);
eb_end = lb(eb_size);
pos = find(seqs == 3 & endbulgesi == 0 & bulges1i == 0);
dst = zeros(size(pos));
if ~isempty(pos)
    side = sign(pos-eb_begin);
    lup = find(side == -1);
    dst(lup) = eb_begin - (pos(lup) + Min_dlength - 1);
    ldwn = find(side == 1);
    dst(ldwn) = pos(ldwn) - eb_end;
end

```

```

    dst(find(dst < 0))= 1000;
    [md,l] = min(dst);
    posi = pos(l);
else
    pos = find(seqsi == 4 & endbulgesi == 0 & bulges1i == 0);
    side = sign(pos-eb_begin);
    lup = find(side == -1);
    dst(lup) = eb_begin - (pos(lup) + Min_dlength -1);
    ldwn = find(side == 1);
    dst(ldwn) = pos(ldwn) - eb_end;
    on_endbulge = find(dst < 0);
    dst(on_endbulge) == 1000;
    [md,l] = min(dst);
    posi = pos(l);
end
return
function [x,y,seqno] = merge_sets(x1,x2,y1,y2,seqno1,seqno2)
%[x,y,seqno] = merge_sets(x1,x2,y1,y2,seqno1,seqno2)
% concatenate datasets
x = [x1; x2];
y = [y1; y2];
seqno = [seqno1; seqno2+max(seqno1)];
return%mfold_cv
mfold = 8;
n_all = length(seqs);
bins = round(0:n_all/mfold:n_all)
bins_all = 1:n_all;
pos5 = zeros(0);
score5 =zeros(0);
m = 1;
while m <= mfold
    bs = [bins(m)+1: bins(m+1)];% test set
    bt = setdiff(bins_all , bs);% train set

    disp(' ');
    disp(['m = ' num2str(m)]);

    [pos5m,score5m] = edit_predict(seqsd(bt), seqs(bs), endbulges(bs));

    pos5 = [pos5,pos5m];
    score5 =[score5,score5m];

    m = m+1;
end
% perform m fold cross validation on article + zucker results by splitting set
validation = 1; % otherwise, only testing is performed
mfold = 5;
n_all = 278;
bins = round(0:n_all/mfold:n_all)
bins_all = 1:n_all;

```

```

x3 = zeros(0);
out3 =zeros(0);
seqno3 = zeros(0);
pos3 = zeros(0);
score3 = zeros(0);
x5 = zeros(0);
out5 =zeros(0);
seqno5 = zeros(0);
pos5 = zeros(0);
score5 = zeros(0);
m = 1;
while m <= mfold
    bs = [bins(m)+1: bins(m+1)];
    % test set
    filename3 = ['svm_tst_3m.dat'];
    filename5 = ['svm_tst_5m.dat'];
    [x3s, seqno3s] = preprocess_and_write_data3(seqs_all(bs),bulges1_all(bs),bulges2_all(bs),endbulges_all(bs),
filename3);
    [x5s, seqno5s] = preprocess_and_write_data5(seqs_all(bs),bulges1_all(bs),bulges2_all(bs),endbulges_all(bs),
filename5);
    disp(['m = ' num2str(m)]);
    disp('written preprocessed test examples');

    bt = setdiff(bins_all , bs);
    filename3 = ['svm_trn_3m.dat'];
    filename5 = ['svm_trn_5m.dat'];
    [x3t, seqno3t] = preprocess_and_write_data3(seqs_all(bt),bulges1_all(bt),bulges2_all(bt),endbulges_all(bt),
filename3, pos_all(bt)+lend_all(bt)-1);
    [x5t, seqno5t] = preprocess_and_write_data5(seqs_all(bt),bulges1_all(bt),bulges2_all(bt),endbulges_all(bt),
filename5, pos_all(bt));
    disp('written preprocessed training examples');

    disp('now train and test svm. results should be in g:\research\rosetta\svm_light_utils1\svm_outputs\out3m.out,
out5m.out');
    disp('*****');

    pause
    cd svm_outputs
    load out3m.out
    load out5m.out
    cd ..
    [pos3m, score3m] = svm_position(x3s,out3m,seqno3s, endbulges_all(bs), lenp_all(bs)+lend_all(bs));
    [pos5m, score5m] = svm_position(x5s,out5m,seqno5s, endbulges_all(bs), lenp_all(bs));
    %collect global variables
    x3 = [x3; x3s];
    out3 =[out3;out3m];
    if m == 1
        seqno3 = seqno3s;
    else
        mx3 = max(seqno3);

```

```

    seqno3 = [seqno3 ; mx3+seqno3s];
end
pos3 = [pos3 pos3m];
score3 = [score3 score3m];

x5 = [x5;x5s];
out5 =[out5,out5m];
if m == 1
    seqno5 = seqno5s;
else
    mx5 = max(seqno5);
    seqno5 = [seqno5 ; mx3+seqno5s];
end
pos5 = [pos5 pos5m];
score5 = [score5 score5m];
m = m+1;
end
%mfold_cv_transduction
% perform m fold cross validation on article + zucker results by splitting set
% use transduction mode of SVM
mfold = 5;
n_all = 278;
bins = round(0:n_all/mfold:n_all)
bins_all = 1:n_all;
x3 = zeros(0);
out3 =zeros(0);
seqno3 = zeros(0);
pos3 = zeros(0);
score3 = zeros(0);
x5 = zeros(0);
out5 =zeros(0);
seqno5 = zeros(0);
pos5 = zeros(0);
score5 = zeros(0);
m = 1;
while m <= mfold
    bs = [bins(m)+1: bins(m+1)];
    %training set
    bt = setdiff(bins_all , bs);
    filename3 = ['svm_trn_3t.dat'];
    filename5 = ['svm_trn_5t.dat'];
    [x3t, seqno3t] = preprocess_and_write_data3(seqs_all(bt),bulges1_all(bt),bulges2_all(bt),endbulges_all(bt),
    filename3, pos_all(bt)+lend_all(bt)-1);
    [x5t, seqno5t] = preprocess_and_write_data5(seqs_all(bt),bulges1_all(bt),bulges2_all(bt),endbulges_all(bt),
    filename5, pos_all(bt));
    disp('written preprocessed training examples');

% test set - append to previous file
    [x3s, seqno3s] = preprocess_and_write_data3_tr(seqs_all(bs),bulges1_all(bs),bulges2_all(bs),endbulges_all(bs),
    filename3);

```

```
[x5s, seqno5s] = preprocess_and_write_data5_tr(seqs_all(bs),bulges1_all(bs),bulges2_all(bs),endbulges_all(bs),
filename5);
```

```
% test set - write to seperate file
filename3 = ['svm_tst_3t.dat'];
filename5 = ['svm_tst_5t.dat'];
[x3s, seqno3s] = preprocess_and_write_data3(seqs_all(bs),bulges1_all(bs),bulges2_all(bs),endbulges_all(bs),
filename3);
[x5s, seqno5s] = preprocess_and_write_data5(seqs_all(bs),bulges1_all(bs),bulges2_all(bs),endbulges_all(bs),
filename5);
disp('written preprocessed testing examples');
disp(['m = ' num2str(m)]);
disp('written preprocessed test examples');
```

```
disp('now train and test svm. ');
disp('transductive data are in svm_trn_5t.dat etc.')
disp('results should be in g:\research\rosetta\svm_light_utils1\svm_outputs\out5t.out, etc. ');
disp('*****');
```

```
pause
cd svm_outputs
load out3t.out
load out5t.out
cd ..
[pos3t, score3t] = svm_position(x3s,out3t,seqno3s, endbulges_all(bs), lenp_all(bs)+lend_all(bs));
[pos5t, score5t] = svm_position(x5s,out5t,seqno5s, endbulges_all(bs), lenp_all(bs));
%collect global variables
x3 = [x3; x3s];
out3 =[out3;out3t];
if m == 1
    seqno3 = seqno3s;
else
    mx3 = max(seqno3);
    seqno3 = [seqno3 ; mx3+seqno3s];
end
pos3 = [pos3 pos3t];
score3 = [score3 score3t];
```

```
%here am
```

```
x5 = [x5;x5s];;
out5 =[out5;out5t];
if m == 1
    seqno5 = seqno5s;
else
    mx5 = max(seqno5);
    seqno5 = [seqno5 ; mx3+seqno5s];
end
pos5 = [pos5 pos5t];
```

```

    score5 = [score5 score5t];
    m = m+1;
end
% perform m fold cross validation on article + zucker results by splitting set
mfold = 8;
n_all = length(seqs);
bins = round(0:n_all/mfold:n_all)
bins_all = 1:n_all;
svm_params = input('enter svm parameters: ','s');
model_filename3 = 'd:/svm_light/model3m';
tst_filename3 = 'd:/rosetta/svm_light_utils1/svm_tst_3m.dat';
trn_filename3 = 'd:/rosetta/svm_light_utils1/svm_trn_3m.dat';
out_filename3 = 'd:/rosetta/svm_light_utils1/out3m.out';
x3 = zeros(0);
out3 = zeros(0);
seqno3 = zeros(0);
m = 1;
while m <= mfold
    bs = [bins(m)+1: bins(m+1)];
    % test set

[x3s, seqno3s] = preprocess_and_write_data3(seqs(bs),bulges1(bs), ...
    bulges2(bs),endbulges(bs), tst_filename3);
    disp(['m = ' num2str(m)]);
    disp('written preprocessed test examples');

    bt = setdiff(bins_all , bs);

    [x3t, seqno3t] = preprocess_and_write_data3(seqs(bt),bulges1(bt),...
        bulges2(bt),endbulges(bt), trn_filename3, pos(bt)+lend(bt)-1);
    disp('written preprocessed training examples');

dos(['d:/svm_light/svm_learn ' svm_params ' ' trn_filename3 ' ' model_filename3]);
dos(['d:/svm_light/svm_classify ' tst_filename3 ' ' model_filename3 ' ' out_filename3]);

load out3m.out

%collect global variables
x3 = [x3;x3s];
out3 =[out3;out3m];
if m == 1
    seqno3 = seqno3s;
else
    mx3 = max(seqno3);
    seqno3 = [seqno3 ; mx3+seqno3s];
end
m = m+1;
end
clear x3s x3t out3m seqno3s seqno3t bs bt
% just for printing the info

```

```

[Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength] = read_params('params3.dat');
disp(' ');
disp('*****');
disp('3 prime end');
disp(['params      : ' num2str([Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength]) '']);
disp(['svm light params: ' svm_params]);
% perform m fold cross validation on article + zucker results by splitting set
mfold = 8;
n_all = length(seqs);
bins = round(0:n_all/mfold:n_all)
bins_all = 1:n_all;
svm_params = input('enter svm parameters: ','s');
model_filename3 = 'd:/svm_light/model3m';
tst_filename3 = 'd:/rosetta/svm_light_utils1/svm_tst_3mb.dat';
trn_filename3 = 'd:/rosetta/svm_light_utils1/svm_trn_3mb.dat';
out_filename3 = 'd:/rosetta/svm_light_utils1/out3mb.out';
x3 = zeros(0);
out3 = zeros(0);
seqno3 = zeros(0);
m = 1;
while m <= mfold
    bs = [bins(m)+1: bins(m+1)];
    % test set

[x3s, seqno3s] = preprocess_and_write_data3(seqs(bs),bulges1(bs), ...
    bulges2(bs),endbulges(bs), tst_filename3);
    disp(['m = ' num2str(m)]);
    disp('written preprocessed test examples');

    bt = setdiff(bins_all , bs);

[x3t, seqno3t] = preprocess_and_write_data3(seqs(bt),bulges1(bt),...
    bulges2(bt),endbulges(bt), trn_filename3, pos(bt)+lend(bt)-1);
    disp('written preprocessed training examples');

dos(['d:/svm_light/svm_learn ' svm_params ' ' trn_filename3 ' ' model_filename3]);
dos(['d:/svm_light/svm_classify ' tst_filename3 ' ' model_filename3 ' ' out_filename3]);

load out3mb.out
out3m= out3mb;

%collect global variables
x3 = [x3;x3s];
out3 =[out3;out3m];
if m == 1
    seqno3 = seqno3s;
else
    mx3 = max(seqno3);
    seqno3 = [seqno3 ; mx3+seqno3s];
end

```

```

    m = m+1;
end
clear x3s x3t out3m out3mb seqno3s seqno3t bs bt
% just for printing the info
[Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength] = read_params('params3.dat');
disp(' ');
disp('*****');
disp('3 prime end');
disp(['params      : ' num2str([Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength]) ]);
disp(['svm light params: ' svm_params]);
% perform m fold cross validation on article + zucker results by splitting set
mfold = 8;
n_all = length(seqs);
bins = round(0:n_all/mfold:n_all)
bins_all = 1:n_all;
svm_params = input('enter svm parameters: ','s');
model_filename5 = 'd:/svm_light/model5m';
tst_filename5 = 'd:/rosetta/svm_light_utils1/svm_tst_5m.dat';
trn_filename5 = 'd:/rosetta/svm_light_utils1/svm_trn_5m.dat';
out_filename5 = 'd:/rosetta/svm_light_utils1/out5m.out';
x5 = zeros(0);
out5 = zeros(0);
seqno5 = zeros(0);
m = 1;
while m <= mfold
    bs = [bins(m)+1: bins(m+1)];
    % test set

[x5s, seqno5s] = preprocess_and_write_data5(seqs(bs),bulges1(bs), ...
    bulges2(bs),endbulges(bs), tst_filename5);
    disp(['m = ' num2str(m)]);
    disp('written preprocessed test examples');

    bt = setdiff(bins_all , bs);

[x5t, seqno5t] = preprocess_and_write_data5(seqs(bt),bulges1(bt),...
    bulges2(bt),endbulges(bt), trn_filename5, pos(bt));
    disp('written preprocessed training examples');

dos(['d:/svm_light/svm_learn ' svm_params ' ' trn_filename5 ' ' model_filename5]);
dos(['d:/svm_light/svm_classify ' tst_filename5 ' ' model_filename5 ' ' out_filename5]);

load out5m.out

%collect global variables
x5 = [x5;x5s];;
out5 =[out5,out5m];
if m == 1
    seqno5 = seqno5s;
else

```

```

        mx5 = max(seqno5);
        seqno5 = [seqno5 ; mx5+seqno5s];
    end
    m = m+1;
end
clear x5s x5t out5m seqno5s seqno5t bs bt
% just for printing the info
[Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength] = read_params('params5.dat');
disp(' ');
disp('*****');
disp('5 prime end');
disp(['params      : ' num2str([Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength]) ]);
disp(['svm light params: ' svm_params]);
% perform m fold cross validation on article + zucker results by splitting set
mfold = 8;
n_all = length(seqs);
bins = round(0:n_all/mfold:n_all)
bins_all = 1:n_all;
svm_params = input('enter svm parameters: ','s');
model_filename5 = 'd:/svm_light/model5m';
tst_filename5 = 'd:/rosetta/svm_light_utils1/svm_tst_5m.dat';
trn_filename5 = 'd:/rosetta/svm_light_utils1/svm_trn_5m.dat';
out_filename5 = 'd:/rosetta/svm_light_utils1/out5m.out';
model_filename3 = 'd:/svm_light/model3m';
tst_filename3 = 'd:/rosetta/svm_light_utils1/svm_tst_3m.dat';
trn_filename3 = 'd:/rosetta/svm_light_utils1/svm_trn_3m.dat';
out_filename3 = 'd:/rosetta/svm_light_utils1/out3m.out';
x3 = zeros(0);
out3 = zeros(0);
seqno3 = zeros(0);
pos3 = zeros(0);
score3 = zeros(0);
x5 = zeros(0);
out5 = zeros(0);
seqno5 = zeros(0);
pos5 = zeros(0);
score5 = zeros(0);
m = 1;
while m <= mfold
    bs = [bins(m)+1: bins(m+1)];
% test set
    [x3s, seqno3s] = preprocess_and_write_data3(seqs(bs),bulges1(bs),bulges2(bs),endbulges(bs), tst_filename3);
    [x5s, seqno5s] = preprocess_and_write_data5(seqs(bs),bulges1(bs),bulges2(bs),endbulges(bs), tst_filename5);
    disp(['m = ' num2str(m)]);
    disp('written preprocessed test examples');

    bt = setdiff(bins_all , bs);
    [x3t, seqno3t] = preprocess_and_write_data3(seqs(bt),bulges1(bt),bulges2(bt),endbulges(bt), trn_filename3,
pos(bt)+lend(bt)-1);
    [x5t, seqno5t] = preprocess_and_write_data5(seqs(bt),bulges1(bt),bulges2(bt),endbulges(bt), trn_filename5,
pos(bt));

```

```

disp('written preprocessed training examples');

dos(['d:/svm_light/svm_learn ' svm_params ' ' trn_filename5 ' ' model_filename5]);
dos(['d:/svm_light/svm_classify ' tst_filename5 ' ' model_filename5 ' ' out_filename5]);
dos(['d:/svm_light/svm_learn ' svm_params ' ' trn_filename3 ' ' model_filename3]);
dos(['d:/svm_light/svm_classify ' tst_filename3 ' ' model_filename3 ' ' out_filename3]);

load(out_filename3);
load(out_filename5)

%[pos3m, score3m] = svm_position(x3s,out3m,seqno3s, endbulges(bs), lenp(bs));
%[pos5m, score5m] = svm_position(x5s,out5m,seqno5s, endbulges(bs), lenp(bs));
%collect global variables
x3 = [x3; x3s];
out3 =[out3;out3m];
if m == 1
    seqno3 = seqno3s;
else
    mx3 = max(seqno3);
    seqno3 = [seqno3 ; mx3+seqno3s];
end
% pos3 = [pos3 pos3m];
% score3 = [score3 score3m];

x5 = [x5;x5s];;
out5 =[out5;out5m];
if m == 1
    seqno5 = seqno5s;
else
    mx5 = max(seqno5);
    seqno5 = [seqno5 ; mx3+seqno5s];
end
% pos5 = [pos5 pos5m];
% score5 = [score5 score5m];
m = m+1;
end
[Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength] = read_params('params5.dat');
disp(' ');
disp('*****');
disp('5 prime end');
disp(['params      : ' num2str([Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength]) ]);
[Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength] = read_params('params3.dat');
disp(' ');
disp('*****');
disp('3 prime end');
disp(['params      : ' num2str([Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength]) ]);
disp(['svm light params: ' svm_params]);% perform m fold cross validation on article + zucker results by splitting set
mfold = 8;
n_all = length(seqs);
bins = round(0:n_all/mfold:n_all)

```

```

bins_all = 1:n_all;
svm_params = input('enter svm parameters: ','s');
model_filename5 = 'd:/svm_light/model5mb';
tst_filename5 = 'd:/rosetta/svm_light_utils1/svm_tst_5mb.dat';
trn_filename5 = 'd:/rosetta/svm_light_utils1/svm_trn_5mb.dat';
out_filename5 = 'd:/rosetta/svm_light_utils1/out5mb.out';
model_filename3 = 'd:/svm_light/model3mb';
tst_filename3 = 'd:/rosetta/svm_light_utils1/svm_tst_3mb.dat';
trn_filename3 = 'd:/rosetta/svm_light_utils1/svm_trn_3mb.dat';
out_filename3 = 'd:/rosetta/svm_light_utils1/out3mb.out';
x3 = zeros(0);
out3 = zeros(0);
seqno3 = zeros(0);
pos3 = zeros(0);
score3 = zeros(0);
x5 = zeros(0);
out5 = zeros(0);
seqno5 = zeros(0);
pos5 = zeros(0);
score5 = zeros(0);
m = 1;
while m <= mfold
    bs = [bins(m)+1: bins(m+1)];
% test set
    [x3s, seqno3s] = preprocess_and_write_data3(seqs(bs),bulges1(bs),bulges2(bs),endbulges(bs), tst_filename3);
    [x5s, seqno5s] = preprocess_and_write_data5(seqs(bs),bulges1(bs),bulges2(bs),endbulges(bs), tst_filename5);
    disp(['m = ' num2str(m)]);
    disp('written preprocessed test examples');

    bt = setdiff(bins_all , bs);
    [x3t, seqno3t] = preprocess_and_write_data3(seqs(bt),bulges1(bt),bulges2(bt),endbulges(bt), trn_filename3,
pos(bt)+lend(bt)-1);
    [x5t, seqno5t] = preprocess_and_write_data5(seqs(bt),bulges1(bt),bulges2(bt),endbulges(bt), trn_filename5,
pos(bt));
    disp('written preprocessed training examples');

    dos(['d:/svm_light/svm_learn ' svm_params ' ' trn_filename5 ' ' model_filename5]);
    dos(['d:/svm_light/svm_classify ' tst_filename5 ' ' model_filename5 ' ' out_filename5]);
    dos(['d:/svm_light/svm_learn ' svm_params ' ' trn_filename3 ' ' model_filename3]);
    dos(['d:/svm_light/svm_classify ' tst_filename3 ' ' model_filename3 ' ' out_filename3]);

    load(out_filename3);
    load(out_filename5)
    out5m = out5mb;
    out3m = out3mb;

    %[pos3m, score3m] = svm_position(x3s,out3m,seqno3s, endbulges(bs), lenp(bs));
    %[pos5m, score5m] = svm_position(x5s,out5m,seqno5s, endbulges(bs), lenp(bs));
%collect global variables
x3 = [x3; x3s];

```

```

out3 =[out3;out3m];
if m == 1
    seqno3 = seqno3s;
else
    mx3 = max(seqno3);
    seqno3 = [seqno3 ; mx3+seqno3s];
end
% pos3 = [pos3 pos3m];
% score3 = [score3 score3m];

x5 = [x5;x5s];;
out5 =[out5;out5m];
if m == 1
    seqno5 = seqno5s;
else
    mx5 = max(seqno5);
    seqno5 = [seqno5 ; mx3+seqno5s];
end
% pos5 = [pos5 pos5m];
% score5 = [score5 score5m];
m = m+1;
end
[Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength] = read_params('params5.dat');
disp(' ');
disp('*****');
disp('5 prime end');
disp(['params      : ' num2str([Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength]) ]);
[Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength] = read_params('params3.dat');
disp(' ');
disp('*****');
disp('3 prime end');
disp(['params      : ' num2str([Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength]) ]);
disp(['svm light params: ' svm_params]);% perform m fold cross validation on article + zucker results by splitting set
% modified file names for input/output so that can be run in parralel
mfold = 5;
n_all = length(seqs);
bins = round(0:n_all/mfold:n_all)
bins_all = 1:n_all;
svm_params = input('enter svm parameters: ','s');
model_filename5 = 'd:/svm_light/model5m_b';
tst_filename5 = 'd:/rosetta/svm_light_utils1/svm_tst_5m_b.dat';
trn_filename5 = 'd:/rosetta/svm_light_utils1/svm_trn_5m_b.dat';
out_filename5 = 'd:/rosetta/svm_light_utils1/out5m_b.out';
x5 = zeros(0);
out5 =zeros(0);
seqno5 = zeros(0);
m = 1;
while m <= mfold
    bs = [bins(m)+1: bins(m+1)];
    % test set

```

```

[x5s, seqno5s] = preprocess_and_write_data5(seqs(bs),bulges1(bs), ...
    bulges2(bs),endbulges(bs), tst_filename5);
disp(['m = ' num2str(m)]);
disp('written preprocessed test examples');

bt = setdiff(bins_all , bs);

[x5t, seqno5t] = preprocess_and_write_data5(seqs(bt),bulges1(bt),...
    bulges2(bt),endbulges(bt), trn_filename5, pos(bt));
disp('written preprocessed training examples');

dos(['d:/svm_light/svm_learn ' svm_params ' ' trn_filename5 ' ' model_filename5]);
dos(['d:/svm_light/svm_classify ' tst_filename5 ' ' model_filename5 ' ' out_filename5]);

load out5m_b.out

%collect global variables
x5 = [x5;x5s];;
out5 =[out5;out5m_b];
if m == 1
    seqno5 = seqno5s;
else
    mx5 = max(seqno5);
    seqno5 = [seqno5 ; mx5+seqno5s];
end
m = m+1;
end
clear x5s x5t out5m_b seqno5s seqno5t bs bt
[Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength] = read_params('params5.dat');
disp(' ');
disp('*****');
disp('5 prime end');
disp(['params      : ' num2str([Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength]) '']);
disp(['svm light params: ' svm_params]);
%mfold_cvk
mfold = 8;
n_all = length(seqs);
bins = round(0:n_all/mfold:n_all)
bins_all = 1:n_all;
k = 4;
pos5 = zeros(0);
score5 =zeros(0);
m = 1;
while m <= mfold
    bs = [bins(m)+1 : bins(m+1)];% test set
    bt = setdiff(bins_all , bs);% train set

    disp(['m = ' num2str(m)]);

```

```

[pos5m,score5m] = edit_predictk(seqsd(bt), seqs(bs), endbulges(bs),k);

pos5 = [pos5,pos5m];
score5 =[score5,score5m];

m = m+1;
end
function [intseq, fault_seq] = nuc2int4_new(strseq);
%[intseq, fault_seq] = nuc2int4_new(strseq)
%convert a sequence of 'A C T G' into a array of 1 2 3 4
intseq = zeros(size(strseq));
fault_seq = 0;
for i = 1:length(strseq)
    switch upper(strseq(i))
        case 'A' , intseq(i) = 1;
        case 'C' , intseq(i) = 2;
        case 'T' , intseq(i) = 3;
        case 'G' , intseq(i) = 4;
        otherwise , intseq = []; fault_seq = 1; break;
    end
end
function run_edit_distance()
infile='c:\editdistance\draw_file.dat';
outfile='c:\editdistance\dicer_res.dat';
cd \\rosetta4\Development\gideon\edit_dist
seqsd = cell(0);
ii=0
fid=fopen('seqsd','r');
while ~feof(fid)
    ii=ii+1;
    seqsd{ii}=fgetl(fid);

end
fclose(fid);
fidin = fopen(infile,'r');
fidout = fopen(outfile,'w');
fidin
seqstot = 1000; %number of sequences to classify each loop
seq_id0 = 0;
while ~feof(fidin)
    disp('reading structure...');
    [seqs,bulges1,bulges2,endbulges,seq_id] = read_structure_fid(fidin, seqstot);
    [pos,score] = edit_predict(seqsd, seqs, endbulges)

%write to file
%seq_id0 is added so as to sequential order of sequence numbers
seq_id = seq_id + seq_id0;
res = [seq_id; pos; score];
fprintf(fidout, '%d %d %g ', res);
seq_id0 = max(seq_id);

```

```

end
fclose(fidin);
fclose(fidout);
quit
return;
function y = prctile(x,p);
%PRCTILE gives the percentiles of the sample in X.
% Y = PRCTILE(X,P) returns a value that is greater than P percent
% of the values in X. For example, if P = 50 Y is the median of X.
%
% P may be either a scalar or a vector. For scalar P, Y is a row
% vector containing Pth percentile of each column of X. For vector P,
% the ith row of Y is the P(i) percentile of each column of X.
% Copyright (c) 1993-98 by The MathWorks, Inc.
% $Revision: 2.6 $ $Date: 1997/11/29 01:46:27 $
[prows pcols] = size(p);
if prows ~= 1 & pcols ~= 1
    error('P must be a scalar or a vector.');
```

```

end
if any(p > 100) | any(p < 0)
    error('P must take values between 0 and 100');
```

```

end
xx = sort(x);
[m,n] = size(x);
if m==1 | n==1
    m = max(m,n);
    if m == 1,
        y = x*ones(length(p),1);
        return;
    end
    n = 1;
    q = 100*(0.5:m - 0.5)./m;
    xx = [min(x); xx(:); max(x)];
else
    q = 100*(0.5:m - 0.5)./m;
    xx = [min(x); xx; max(x)];
end
q = [0 q 100];
y = interp1(q,xx,p);
function seqtable = prepare_seqtable(seqno_list);
% seqtable = prepare_seqtable(seqno);
%seqtable contains for each seqno its starting location in example list
% and its end location
seqtable = zeros(max(seqno_list),2);
i = 1;
seqno = seqno_list(i);
while i <= length(seqno_list)
    seqtable(seqno,1) = i;
    while seqno_list(i) == seqno
        seqtable(seqno,2) = i;
```

```

    i = i+1;
    if i > length(seqno_list)
        break
    end
end
if i > length(seqno_list)
    break
end
seqno = seqno_list(i);
end
return

```

```

function [x12, seqno] = preprocess_and_write_data3(seqsp,bulges1,bulges2,endbulges, filename, pos)
%[x12, seqno] = preprocess_and_write_data3(seqsp,bulges1,bulges2,endbulges,filename, pos+lend-1);
%[x12, seqno] = preprocess_and_write_data3(seqsp,bulges1,bulges2,endbulges,filename); %testing mode
% notice that here pos is pos
%x12 are the first two elements of x (side , relative_loopdist)
%high level function for preparing data and writing for svm training
global Nnucfrom Nnucto Nbfrom Nbto mode
global Min_dlength
[Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength] = read_params('params3.dat');
if nargin == 5
    mode = 'testing';
else
    mode = 'training';
end
x12 = zeros(0);
seqno = zeros(0);
fid = fopen(filename,'w');
for i = 1:length(seqsp)
    if strcmp(mode,'training')
        [xi, yi] = preprocess3(seqsp{i},bulges1{i},bulges2{i},endbulges{i},pos(i));
    elseif strcmp(mode,'testing')
        [xi, yi] = preprocess3(seqsp{i},bulges1{i},bulges2{i},endbulges{i},NaN);
    end
    write_examples(xi, yi, fid);
    x12 = [x12; xi(:,1:2)];
    seqno = [seqno; i*ones(size(xi,1),1)];

    if mod(i,100) == 0; i, end
end
fclose(fid);
return

function [x12, seqno] = preprocess_and_write_data3(seqsp,bulges1,bulges2,endbulges, filename, pos)
%[x12, seqno] = preprocess_and_write_data3(seqsp,bulges1,bulges2,endbulges,filename, pos+lend-1);
%[x12, seqno] = preprocess_and_write_data3(seqsp,bulges1,bulges2,endbulges,filename); %testing mode
% notice that here pos is pos
%x12 are the first two elements of x (side , relative_loopdist)

```

```

%high level function for preparing data and writing for svm training
global Nnucfrom Nnucto Nbfrom Nbto mode
global Min_dlength
[Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength] = read_params('params3.dat');
if nargin == 5
    mode = 'testing';
else
    mode = 'training';
end
x12 = zeros(0);
seqno = zeros(0);
fid = fopen(filename,'a');
for i = 1:length(seqsp)
    if strcmp(mode,'training')
        [xi, yi] = preprocess3(seqsp{i},bulges1{i},bulges2{i},endbulges{i},pos(i));
    elseif strcmp(mode,'testing')
        [xi, yi] = preprocess3(seqsp{i},bulges1{i},bulges2{i},endbulges{i},NaN);
    end
    write_examples(xi, yi, fid);
    x12 = [x12; xi(:,1:2)];
    seqno = [seqno; i*ones(size(xi,1),1)];

    if mod(i,100) == 0; i, end
end
fclose(fid);
return
function [x12, seqno] = preprocess_and_write_data5(seqsp,bulges1,bulges2,endbulges, filename, pos)
%[x12, seqno] = preprocess_and_write_data5(seqsp,bulges1,bulges2,endbulges,filename, pos);
%[x12, seqno] = preprocess_and_write_data5(seqsp,bulges1,bulges2,endbulges,filename); %testing mode
%x12 are the first two elements of x (side , relative_loopdist)
%high level function for preparing data and writing for svm training
global Nnucfrom Nnucto Nbfrom Nbto mode
global Min_dlength
[Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength] = read_params('params5.dat');
if nargin == 5
    mode = 'testing';
else
    mode = 'training';
end
%Maxsize is a simple upper bound for the number of possible positions
Maxsize = 0;
for i = 1:length(seqsp);
    Maxsize = Maxsize+length(seqsp{i});
end
x12 = zeros(Maxsize,2);
seqno = zeros(Maxsize,1);
xfrom = 1; % index where to write into xi and seqno
fid = fopen(filename,'w');
for i = 1:length(seqsp)

```

```

if strcmp(mode,'training')
    [xi, yi] = preprocess5(seqsp{i},bulges1{i},bulges2{i},endbulges{i},pos(i));
elseif strcmp(mode,'testing')
    [xi, yi] = preprocess5(seqsp{i},bulges1{i},bulges2{i},endbulges{i},NaN);
end

write_examples(xi, yi, fid);
xlength = size(xi,1);

x12(xfrom: xfrom + xlength-1,:) = xi(:,1:2);
seqno(xfrom: xfrom + xlength-1) = i*ones(xlength,1);
xfrom = xfrom + xlength ;

if mod(i,1000) == 0; disp(i); end
end
fclose(fid);
% remove the unneeded sapce in x12 and seqno
x12(xfrom:Maxsize,:) = [];
seqno(xfrom:Maxsize) = [];
return
function [x12, seqno] = preprocess_and_write_data5(seqsp,bulges1,bulges2,endbulges, filename, pos)
%[x12, seqno] = preprocess_and_write_data5(seqsp,bulges1,bulges2,endbulges,filename, pos);
%[x12, seqno] = preprocess_and_write_data5(seqsp,bulges1,bulges2,endbulges,filename); %testing mode
%x12 are the first two elements of x (side , relative_loopdist)
%high level function for preparing data and writing for svm training
global Nnucfrom Nnucto Nbfrom Nbto mode
global Min_dlength
[Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength] = read_params('params5.dat');
if nargin == 5
    mode = 'testing';
else
    mode = 'training';
end
x12 = zeros(0);
seqno = zeros(0);
fid = fopen(filename,'a');
for i = 1:length(seqsp)
    if strcmp(mode,'training')
        [xi, yi] = preprocess5(seqsp{i},bulges1{i},bulges2{i},endbulges{i},pos(i));
    elseif strcmp(mode,'testing')
        [xi, yi] = preprocess5(seqsp{i},bulges1{i},bulges2{i},endbulges{i},NaN);
    end

    write_examples(xi, yi, fid);
    x12 = [x12; xi(:,1:2)];
    seqno = [seqno; i*ones(size(xi,1),1)];

    if mod(i,100) == 0; i, end
end
fclose(fid);

```

```

return
function [x,y,seqno] = preprocess_data3(seqsp,bulges1,bulges2,endbulges,pos)
%[x,y,seqno] = preprocess_data3(seqsp,bulges1,bulges2,endbulges,pos); % for training
%[x,y,seqno] = preprocess_data3(seqsp,bulges1,bulges2,endbulges); % for testing
%
% 3' side of MiR
%
global Nnucfrom Nnucto Nbfrom Nbto mode
global Min_dlength
[Nnucfrom, Nnucto, Nbfrom, Nbto, Mindlength] = read_params('params3.dat');
if nargin == 5
    mode = 'training';
else
    mode = 'testing';
end
x = zeros(0);
y = zeros(0);
seqno = zeros(0);
if strcmp(mode,'training')
    for i = 1:length(seqsp)
        [xi, yi] = preprocess3(seqsp{i},bulges1{i},bulges2{i},endbulges{i},pos(i));
        x = [x; xi];
        y = [y; yi];
        seqno = [seqno; i*ones(size(yi))];
        if mod(i,10) == 0; i, end
    end
else
    for i = 1:length(seqsp)
        [xi, yi] = preprocess3(seqsp{i},bulges1{i},bulges2{i},endbulges{i});
        x = [x; xi];
        y = [y; yi]; % this is just a list of zeros
        seqno = [seqno; i*ones(size(yi))];
        if mod(i,10) == 0; i, end
    end
end
returnfunction [x,y,seqno] = preprocess_data5(seqsp,bulges1,bulges2,endbulges,pos)
%[x,y,seqno] = preprocess_data5(seqsp,bulges1,bulges2,endbulges,pos); % for training
%[x,y,seqno] = preprocess_data5(seqsp,bulges1,bulges2,endbulges); % for testing
%high level function for preparing data for svm training
global Nnucfrom Nnucto Nbfrom Nbto mode
global Min_dlength
Nnucfrom = -2; % nucleotides region of interest
Nnucto = 7;
Nbfrom = -2; %bulges region of interest
Nbto = 6;
Min_dlength = 17; % min dicer length
if nargin == 5
    mode = 'training';
else
    mode = 'testing';
end

```

```

end
x = zeros(0);
y = zeros(0);
seqno = zeros(0);
if strcmp(mode,'training')
    for i = 1:length(seqsp)
        [xi, yi] = preprocess5(seqsp{i},bulges1{i},bulges2{i},endbulges{i},pos(i));
        x = [x; xi];
        y = [y; yi];
        seqno = [seqno; i*ones(size(yi))];
        if mod(i,10) == 0; i, end
    end
else
    for i = 1:length(seqsp)
        [xi, yi] = preprocess5(seqsp{i},bulges1{i},bulges2{i},endbulges{i});
        x = [x; xi];
        y = [y; yi]; % this is just a list of zeros
        seqno = [seqno; i*ones(size(yi))];
        if mod(i,10) == 0; i, end
    end
end
returnfunction x = preprocess_window(posj, seqwin,bulges1win,bulges2win, seq_size, eb_size, eb_begin, eb_end)
%preprocess_window : lower level function
% produces a feature vector from 3windows of the sequence
global Nnucfrom Nnucto Nbfrom Nbto mode
lenx = 2 + length(seqwin) *4 + 2*length(bulges1win);
x = zeros(0);
side = sign(posj-eb_begin);
x(1) = side; % -1 for upper, 1 for lower
loopdist = (1 + side)/2 * (posj - eb_end) + ... % lower part
(1 -side)/2* (eb_begin - posj); % upper part
% normalize x2 by palyndrom available length
x(2) = loopdist/(0.5* (seq_size - eb_size));
n_assigned = 2;
binseq = zeros(4, Nnucto+1-Nnucfrom);
binseq([0:size(binseq,2)-1]*4 + seqwin) = 1;
binseq = binseq(:)';
x(n_assigned+1: n_assigned +length(binseq)) = binseq;
n_assigned = n_assigned + length(binseq);
x(n_assigned+1: n_assigned +2*length(bulges1win)) = [bulges1win bulges2win];
returnfunction [xi, yi] = preprocess3(seqspi,bulges1i,bulges2i,endbulgesi,posi)
% low level function aimed at processing a sigle sequence
%in testing mode, yi are simply 0;
global Nnucfrom Nnucto Nbfrom Nbto mode
global Min_dlength
seq_size = length(seqspi); % size of palindrome = # nucleotides
l = find(endbulgesi);
eb_size = length(l); % size of endbulge = loop
eb_begin = l(1);
eb_end = l(eb_size);

```

```

xi = zeros(0);
yi = zeros(0);
% range include for upper and lower 5' positions
from = min(Nbfrom,Nnucfrom);
to = max(Nbto, Nnucto);
for side = -1:2:1
    if side == -1
        posrange = Min_dlength : eb_begin-1-to;
    else
        posrange = eb_end+Min_dlength : seq_size-to;
    end

    for j = 1:length(posrange)
        posj = posrange(j);

        nuc_win = posj+Nnucfrom:posj+Nnucto; %window of nucleotides (sequence)
        b_win = posj+Nbfrom:posj+Nbto; %window of bulges (1 sided & 2 sided)

        %%%%%%%%%%%%%%
        if length(seqspi) < max(nuc_win)
            disp('bug1')
        end
        if length(bulges1i) < max(b_win)| length(bulges2i) < max(b_win)
            disp('bug2')
        end
        %%%%%%%%%%%%%%

        xij = preprocess_window(posj, seqspi(nuc_win), ...
            bulges1i(b_win),bulges2i(b_win), seq_size, eb_size, eb_begin, eb_end);
        xi = [xi; xij];
        if strcmp(mode,'training')
            yij = (posj == posi)*2-1; %+1 or -1
            yi = [yi ; yij];
        else
            yi = [yi ; 0];
        end
    end % for j = 1:length(posrange)
end % if side ==

returnfunction [xi, yi] = preprocess5(seqspi,bulges1i,bulges2i,endbulgesi,posi)
% low level function aimed at processing a sigle sequence
%in testing mode, yi are simply 0;
global Nnucfrom Nnucto Nbfrom Nbto mode
global Min_dlength
%disp('preprocess5 modified. target id triangle like near 5 prime end');
seq_size = length(seqspi); % size of palindrome = # nucleotides
l = find(endbulgesi);
eb_size = length(l); % size of endbulge = loop
eb_begin = l(1);
eb_end = l(eb_size);

```

```

xi = zeros(0);
yi = zeros(0);
% range include for upper and lower 5' positions
from = min(Nbfrom,Nnucfrom);
to = max(Nbto, Nnucto);
for side = -1:2:1
    if side == -1
        posrange = 1+abs(from) :eb_begin-Min_dlength;
    else
        posrange = eb_end+1+abs(from) : seq_size+1-Min_dlength;
    end

    for j = 1:length(posrange)
        posj = posrange(j);

        nuc_win = posj+Nnucfrom:posj+Nnucto; %window of nucleotides (sequence)
        b_win = posj+Nbfrom:posj+Nbto; %window of bulges (1 sided & 2 sided)
        xij = preprocess_window(posj, seqspi(nuc_win), ...
            bulges1i(b_win),bulges2i(b_win), seq_size, eb_size, eb_begin, eb_end);
        xi = [xi; xij];

        if strcmp(mode,'training')
            yij = (posj == posi)*2-1; %+1 or -1
            % new version suitable for regression
            %yij = max(1-0.5*abs(posj-posi), -1); % giving 1 at max and -1 at distance 3 or more
            yi = [yi ; yij];
        else
            yi = [yi ; 0];
        end
    end % for j = 1:length(posrange)
end % if side ==

return[pos5,score5] = svm_position(x5,out5, seqno5, endbulges, lenp);
svkernel = input('enter kernel name: ','s');
targetdir = input('enter target directory name (e.g.) params-1-10-1-10: ','s');
targetfile = ['d:\rosetta\svm_light_utils\figures_174\' targetdir '\ svkernel];
figure(1); analyse_errors_thresh(pos5,score5,pos,endbulges); title(svkernel);
eval(['print -djpeg90 ' targetfile 'thresh']);
figure(2); analyse_errors_perc(pos5,score5,pos,endbulges); title(svkernel);
eval(['print -djpeg90 ' targetfile 'perc']);
in='c:\rosetta\data_baseline_15_5\draw_file2K.dat';
o = 'edist_res_file_hmdc257_2000pals.txt';
run_edit_distance_ranit(in,o);
in='c:\rosetta\data_baseline_15_5\200VirusesDraw.txt';
o = 'edist_res_file_hmdc257_virus.txt';
run_edit_distance_ranit(in,o);
in='c:\rosetta\data_baseline_15_5\badPalsGrade.txt';
o = 'edist_res_file_hmdc257_lowpal.txt';
run_edit_distance_ranit(in,o);
in='c:\rosetta\data_baseline_15_5\goodPalsGrade33.txt';
o = 'edist_res_file_hmdc257_highpal.txt';

```

```

run_edit_distance_ranit(in,o);function [Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength] = read_params(paramsfile);
%[Nnucfrom, Nnucto, Nbfrom, Nbto, Mindlength] = read_params(paramsfile);
Nfields = 5;
fieldnames = cell(Nfields);
fieldnames(1:Nfields) = {'Nnucfrom'; 'Nnucto'; 'Nbfrom'; 'Nbto' ; 'Min_dlength'};
fid = fopen(paramsfile,'r');
while ~feof(fid)
    line = fgetl(fid);
    [field, rest] = strtok(line);

    if ~isempty(rest)
        value = num2str(strtok(rest));
    else
        error(['value of ' field ' not specified']);
    end

    % assign the value to the proper variable
    found = 0;
    for i = 1:Nfields
        if strcmp(field, fieldnames{i})
            eval(['field '=' num2str(value) ']);
            found = 1;
            break
        end
    end
    if found == 0
        error(['illegal field ' field ]);
    end
end
fclose(fid);
return

```

```

function [seqs,len] = read_seq(filename);
%[len,seqs] = read_seq(filename);
%reads dicer or pal sequences into cell array, in numeric format
fid = fopen(filename,'r');
if fid == -1
    error([' file ' filename ' could not be opened']);
end
id = 0;
seq_no = 0;
while ~feof(fid)
    line = fgetl(fid);
    line = deblank(line);
    [intseq, fault_seq] = nuc2int4_new(line);
    id = id + 1;
    if fault_seq == 0
        seq_no = seq_no + 1;
        seqs{seq_no} = intseq;
        len(seq_no) = length(intseq);
    end
end

```

```

else
    disp(['faulty seq on id ' num2str(id)])
end

if(mod(seq_no,1000) == 0 & seq_no ~= 0)
    disp(['seq_no ' num2str(seq_no)]);
end
end
fclose(fid);
return

function [seqs,bulges1,bulges2,endbulges,seq_id] = read_structure(filename);
%[seqs,bulges1,bulges2,endbulges,seq_id] = read_structure(filename)
% read zucker structure
% seq is a cell array containing sequences
% bulge1 is a cell array with binary strings with 1 for one sided bulge (not incl. end bulge)
% bulge2 is similarly for 2 sided bulge
% endbulge is a cell array with binary strings with 1 on the end bulge only
Mxplen = 250; % maximal length of palindrom
if nargin == 0
    filename = 'C:\rosetta_versions\ver9\data\zucker_draw_z.txt';
end
fid = fopen(filename,'r');
seq_no = 0;
seqs = cell(0);
bulges1= cell(0);
bulges2= cell(0);
endbulges = cell(0);
seq_id = zeros(0);
id = 0;
while ~feof(fid)
    structure = char(4,250);
    for i = 1:4
        line = fgetl(fid);
        structure(i,1:length(line)) = line;
    end
    id = id +1;
    [seqi, bulge1i, bulge2i, endbulgei] = get_features(structure);
    [intseq, fault_seq] = nuc2int4_new(seqi);
    if fault_seq == 0
        seq_no = seq_no + 1;
        seqs{seq_no} = intseq;
        bulges1{seq_no} = bulge1i;
        bulges2{seq_no} = bulge2i;
        endbulges{seq_no} = endbulgei;
        seq_id(seq_no) = id;
    else
        disp(['faulty seq on id ' num2str(id)])
    end
    if(mod(seq_no,1000) == 0)

```

```

        seq_no
    end
end
fclose(fid);
return
function [seq, bulge1, bulge2, endbulge] = get_features(structure)
% get sequence as well as bulge structure
%upper half (5' side)
bulge_row = 1; % the row of bulge letters
bulge_row_opposite = 4;
uphalf = structure(1:2,:);
[j,k] = find(isletter(uphalf));
max_col = max(k);
count = 0;
for col = 1: max_col
    fl = find(isletter(uphalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        seq(count) = uphalf(fl,col);
        bulge = (fl == bulge_row);
        bulge1(count) = 0;
        bulge2(count) = 0;
        if bulge & isletter(structure(bulge_row_opposite,col))
            bulge2(count) = 1;
        elseif bulge & ~isletter(structure(bulge_row_opposite,col))
            bulge1(count) = 1;
        end
    end
end
% endbulge is coded on the upper half
% go backwards from 3' side to 5' side
endbulge = zeros(size(bulge1));
pos = length(bulge1);
while bulge1(pos) == 1
    endbulge(pos) = 1;
    bulge1(pos) = 0;
    pos = pos - 1;
end
%lower half
bulge_row = 2; % 4 th line on structure is 2 line on lower half
bulge_row_opposite = 1;
lwhalf = structure(3:4,:);
[j,k] = find(isletter(lwhalf));
max_col = max(k);
for col = max_col:-1:1
    fl = find(isletter(lwhalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        seq(count) = lwhalf(fl,col);
        bulge = (fl == bulge_row);
    end
end

```

```

    bulge1(count) = 0;
    bulge2(count) = 0;
    if bulge & isletter(structure(bulge_row_opposite,col))
        bulge2(count) = 1;
    elseif bulge & ~isletter(structure(bulge_row_opposite,col))
        bulge1(count) = 1;
    end
    endbulge(count) = 0;
end
end
return

function [seqs,bulges1,bulges2,endbulges,seq_id] = read_structure_fid(fid,seqtot);
%[seqs,bulges1,bulges2,endbulges,seq_id] = read_structure_fid(fid,seqtot)
% file id version: read 'seqtot' zucker draw palindromes from file handle 'fid'
%
% read zucker structure
% seq is a cell array containing sequences
% bulge1 is a cell array with binary strings with 1 for one sided bulge (not incl. end bulge)
% bulge2 is similarly for 2 sided bulge
% endbulge is a cell array with binary strings with 1 on the end bulge only
Mxplen = 250; % maximal length of palindrom
global Nnucfrom Nnucto Nbfrom Nbto mode
global Min_dlength
[Nnucfrom, Nnucto, Nbfrom, Nbto, Min_dlength] = read_params('params5.dat');
seq_no = 0;
seqs = cell(0);
bulges1= cell(0);
bulges2= cell(0);
endbulges = cell(0);
seq_id = zeros(0);
id = 0;
while ~feof(fid) & seq_no < seqtot
    structure = char(4,250);
    for i = 1:4
        line = fgetl(fid);
        structure(i,1:length(line)) = line;
    end
    id = id + 1;
    [seqi, bulge1i, bulge2i, endbulgei] = get_features(structure);
    [intseq, fault_seq] = nuc2int4_new(seqi);
    fault_structure = check_structure(seqi, bulge1i, bulge2i, endbulgei);

    if fault_seq == 0 & fault_structure == 0
        seq_no = seq_no + 1;
        seqs{seq_no} = intseq;
        bulges1{seq_no} = bulge1i;
        bulges2{seq_no} = bulge2i;
        endbulges{seq_no} = endbulgei;
        seq_id(seq_no) = id;
    end
end

```

```

else
    disp(['faulty seq on id ' num2str(id)])
end
if(mod(seq_no,1000) == 0)
    seq_no
end
end
return
function [seq, bulge1, bulge2, endbulge] = get_features(structure)
% get sequence as well as bulge structure
%upper half (5' side)
bulge_row = 1; % the row of bulge letters
bulge_row_opposite = 4;
uphalf = structure(1:2,:);
[j,k] = find(isletter(uphalf));
max_col = max(k);
count = 0;
for col = 1: max_col
    fl = find(isletter(uphalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        seq(count) = uphalf(fl,col);
        bulge = (fl == bulge_row);
        bulge1(count) = 0;
        bulge2(count) = 0;
        if bulge & isletter(structure(bulge_row_opposite,col))
            bulge2(count) = 1;
        elseif bulge & ~isletter(structure(bulge_row_opposite,col))
            bulge1(count) = 1;
        end
    end
end
end
% endbulge is coded on the upper half
% go backwards from 3' side to 5' side
endbulge = zeros(size(bulge1));
pos = length(bulge1);
if(pos < 1)
    return
end
while bulge1(pos) == 1
    endbulge(pos) = 1;
    bulge1(pos) = 0;
    pos = pos - 1;
end
%lower half
bulge_row = 2; % 4 th line on structure is 2 line on lower half
bulge_row_opposite = 1;
lwhalf = structure(3:4,:);
[j,k] = find(isletter(lwhalf));
max_col = max(k);

```

```

for col =max_col:-1:1
    fl = find(isletter(lwhalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        seq(count) = lwhalf(fl,col);
        bulge = (fl == bulge_row);
        bulge1(count) = 0;
        bulge2(count) = 0;
        if bulge & isletter(structure(bulge_row_opposite,col))
            bulge2(count) = 1;
        elseif bulge & ~isletter(structure(bulge_row_opposite,col))
            bulge1(count) = 1;
        end
        endbulge(count) = 0;
    end
end
return
function fault_structure = check_structure(seq_i, bulge1_i, bulge2_i, endbulge_i)
%test whether structure can be worked out by classifier, e.g.
% length of sequence is too short not enough space for Mir of length Mindlength
global Nnucfrom Nnucto Nbfrom Nbto mode
global Min_dlength
seq_size = length(seq_i);
lb = find(endbulge_i);
if(isempty(lb))
    fault_structure=1
    return
end
eb_size = length(lb);
eb_begin = lb(1);
eb_end = lb(eb_size);
% how many nucleotides/bulges are taken before 5' position
from = min(Nbfrom,Nnucfrom);
if (1+abs(from) > eb_begin-Min_dlength) & ...
    (eb_end+1+abs(from) > seq_size+1-Min_dlength)
    fault_structure = 1;
else
    fault_structure = 0;
end
return

function [seqs,bulges1,bulges2,endbulges,seq_id, conn] = read_structure_new(filename);
%[seqs,bulges1,bulges2,endbulges,seq_id,conn] = read_structure_new(filename)
% read zucker structure
% updated 22.1
% extractes also connection structure:
% conn(i) = index of nucleotide connected to nucleotide i (0 if unconnected);
% seq is a cell array containing sequences
% bulge1 is a cell array with binary strings with 1 for one sided bulge (not incl. end bulge)
% bulge2 is similarly for 2 sided bulge

```

```

% endbulge is a cell array with binary strings with 1 on the end bulge only
Mxplen = 250; % maximal length of palindrom
if nargin == 0
    filename = 'C:\rosetta_versions\ver9\data\zucker_draw_z.txt';
end
fid = fopen(filename,'r');
seq_no = 0;
seqs = cell(0);
bulges1= cell(0);
bulges2= cell(0);
endbulges = cell(0);
seq_id = zeros(0);
conn = cell(0);
id = 0;
while ~feof(fid)
    structure = char(4,250);
    for i = 1:4
        line = fgetl(fid);
        structure(i,1:length(line)) = line;
    end
    id = id + 1;
    [seqi, bulge1i, bulge2i, endbulgei, conni] = get_features(structure);
    [intseq, fault_seq] = nuc2int4_new(seqi);
    if fault_seq == 0
        seq_no = seq_no + 1;
        seqs{seq_no} = intseq;
        bulges1{seq_no} = bulge1i;
        bulges2{seq_no} = bulge2i;
        endbulges{seq_no} = endbulgei;
        seq_id(seq_no) = id;
        conn{seq_no} = conni;
    else
        disp(['faulty seq on id ' num2str(id)])
    end
    if(mod(seq_no,1000) == 0)
        seq_no
    end
end
return
function [seq, bulge1, bulge2, endbulge, conn] = get_features(structure)
% get sequence as well as bulge structure
% sequence index of nucleotide in structure
structure_seq_ind = zeros(size(structure));
%upper half (5' side)
bulge_row = 1; % the row of bulge letters
bulge_row_opposite = 4;
[j,k] = find(isletter(structure(1:2,:)));
max_col = max(k);
count = 0;
for col =1: max_col

```

```

fl = find(isletter(structure(1:2,col)));
if ~isempty(fl)
    count = count + 1;
    seq(count) = structure(1:2,col);
    bulge = (fl == bulge_row);
    bulge1(count) = 0;
    bulge2(count) = 0;
    if bulge & isletter(structure(bulge_row_opposite,col))
        bulge2(count) = 1;
    elseif bulge & ~isletter(structure(bulge_row_opposite,col))
        bulge1(count) = 1;
    end
    structure_seq_ind(col, fl) = count;
end
end
% endbulge is coded on the upper half
% go backwards from 3' side to 5' side
endbulge = zeros(size(bulge1));
pos = length(bulge1);
while bulge1(pos) == 1
    endbulge(pos) = 1;
    bulge1(pos) = 0;
    pos = pos - 1;
end
%lower half
bulge_row = 4; % 4 th line on structure is 2 line on lower half
bulge_row_opposite = 1;
[j,k] = find(isletter(structure(3:4,:)));
max_col = max(k);
for col =max_col:-1:1
    fl = find(isletter(structure(3:4,col)));
    if ~isempty(fl)
        fl = fl+2; % add 2 since fl = 1/2 on structure(3:4,:
        count = count + 1;
        seq(count) = structure(fl,col);
        bulge = (fl == bulge_row);
        bulge1(count) = 0;
        bulge2(count) = 0;
        if bulge & isletter(structure(bulge_row_opposite,col))
            bulge2(count) = 1;
        elseif bulge & ~isletter(structure(bulge_row_opposite,col))
            bulge1(count) = 1;
        end
        endbulge(count) = 0;
        structure_seq_ind(col, fl) = count;
    end
end
% produce connection structure
conn = zeros(size(seq));
[j,k] = find(structure_seq_ind(2:3,:) ~= 0);

```

```

j_opp = 5-j; %opposite to j. 3 <-> 2
% produce connection matrix in simple representation
for i = 1:length(j)
    conn(structure_seq_ind(j(i),k(i))) = structure_seq_ind(j_opp(i),k(i));
end
return
function [seqsd, seqs,bulges1,bulges2,endbulges,seq_id] = remove_duplicates(seqsd,
seqs,bulges1,bulges2,endbulges,seq_id);
%[seqsd, seqs,bulges1,bulges2,endbulges,seq_id] = remove_duplicates(seqsd,
seqs,bulges1,bulges2,endbulges,seq_id);
% locate only unique palindrome-dicer pairs
% dicers must be sorted lexicographically
if length(seqsd) ~= length(seqs)
    error('seqsd and seqs not compatible');
end
ldl = zeros(length(seqsd),1); %entries to be deleted
for i = 2:length(seqsd)
    if length(seqsd{i}) == length(seqsd{i-1}) & length(seqs{i}) == length(seqs{i-1})
        if all(seqsd{i} == seqsd{i-1}) & all(seqs{i} == seqs{i-1})
            ldl(i) = 1;
        end
    end
end
%delete duplicates
l = find(ldl);
seqsd(l) = [];
seqs(l) = [];
bulges1(l) = [];
bulges2(l) = [];
endbulges(l) = [];
seq_id(l) = [];
return

% perform a partitioned testing on large data
mfold = 3;
n_all = length(seqs);
bins = round(0:n_all/mfold:n_all)
bins_all = 1:n_all;
m = 1;
fname = 'res_poly3_33156.out';
fid = fopen(fname, 'a');
while m <= mfold
    bs = [bins(m)+1: bins(m+1)];
    % test set
    filename3 = ['svm3_33156m.dat'];
    filename5 = ['svm5_33156m.dat'];

    [x3s, seqno3s] = preprocess_and_write_data3(seqs(bs),bulges1(bs),bulges2(bs),endbulges(bs), filename3);
    [x5s, seqno5s] = preprocess_and_write_data5(seqs(bs),bulges1(bs),bulges2(bs),endbulges(bs), filename5);
    disp(['m = ' num2str(m)]);
end

```

```

disp('written preprocessed test examples');

disp('now run svm_classify. inputs are svm3_33156m.dat and svm5_33156m.dat');
disp('results should be in g:\research\rosetta\svm_light_utils1\svm_outputs\out3m.out, out5m.out');
disp('*****');

pause
cd svm_outputs

% test that both out files exist
files_ok = 0;
while files_ok == 0;
    files_ok = 1;
    fid5 = fopen('out5m.out','r');
    fid3 = fopen('out3m.out','r');

    if fid5 == -1
        files_ok = 0;
        disp('run svm_classify on 3 data. out3m.out not found. enter when ready');
        pause
    else
        fclose(fid5);
    end

    if fid3 == -1
        files_ok = 0;
        disp('run svm_classify on 3 data. out3m.out not found. enter when ready');
        pause
    else
        fclose(fid3);
    end
end

load out3m.out
load out5m.out
%delete files to insure that on next iteration, files are new
delete out3m.out
delete out5m.out

cd ..

%[pos3m, score3m] = svm_position(x3s,out3m,seqno3s, endbulges(bs), lenp(bs));
%[pos5m, score5m] = svm_position(x5s,out5m,seqno5s, endbulges(bs), lenp(bs));
[pos53m, score53m] = svm_position53(x5s,out5m,seqno5s, x3s,out3m,seqno3s, endbulges(bs), lenp(bs));

[yside, yprec2] = interpolate_probabilities(score53m, 'poly3');

res = [seq_id(bs); pos53m(:,1)'; pos53m(:,2)'; score53m'; yside'; yprec2'];
fprintf(fid, '%d %d %d %g %g %g\n', res);

```

```

    m = m+1;
end
fclose(fid);
function run_edit_distance()
%run_edit_distance(dicerfile, palfile, outfile)
fitfile = '\\rosetta4\\Development\\gideon\\edit_dist\\fit_21_025_1.txt'; %suitable for parameter alpha = 0.25
dicerfile='\\rosetta4\\Development\\gideon\\edit_dist\\seqsd'
palfile='c:\\editdistance\\draw_file.dat';
outfile='c:\\editdistance\\dicer_res.dat';
cd \\rosetta4\\Development\\gideon\\edit_dist
[seqsd,len] = read_seq(dicerfile);
%transform to string
length(seqsd)
for i = 1: length(seqsd)
    seqsd{i} = int2nuc(seqsd{i}, 'uppercase');
end
fidin = fopen(palfile, 'r');
fidout = fopen(outfile, 'a');
seqstot = 1000; %number of sequences to classify each loop
seq_id0 = 0;
while ~feof(fidin)
    disp('reading structure...');
    [seqs, bulges1, bulges2, endbulges, seq_id] = read_structure_fid(fidin, seqstot);

    %transform back to string
    for i = 1: length(seqs)
        seqs{i} = int2nuc(seqs{i}, 'uppercase');
    end

    [pos, score] = edit_predict(seqsd, seqs, endbulges)

    %write to file
    %seq_id0 is added so as to sequential order of sequence numbers
    seq_id = seq_id + seq_id0;

    % interpolate
    [yside, yprec2] = interpolate_prob_new(score, fitfile);
    res = [seq_id; pos; score; yprec2; yside];
    fprintf(fidout, '%d %d %g %g %g ', res);
    seq_id0 = max(seq_id);
end
fclose(fidin);
fclose(fidout);
quit
function run_edit_distance()
infile='c:\\editdistance\\draw_file.dat';
outfile='c:\\editdistance\\dicer_res.dat';
cd \\rosetta4\\Development\\gideon\\edit_dist
seqsd = cell(0);

```

```

ii=0
fid=fopen('seqsd','r');
while ~feof(fid)
    ii=ii+1;
    seqsd{ii}=fgetl(fid);

end
fclose(fid);
fidin = fopen(infile,'r');
fidout = fopen(outfile,'w');
fidin
seqstot = 1000; %number of sequences to classify each loop
seq_id0 = 0;
while ~feof(fidin)
    disp('reading structure...');
    [seqs,bulges1,bulges2,endbulges,seq_id] = read_structure_fid(fidin, seqstot);
    [pos,score] = edit_predict(seqsd, seqs, endbulges)

%write to file
%seq_id0 is added so as to sequential order of sequence numbers
seq_id = seq_id + seq_id0;
res = [seq_id; pos; score];
fprintf(fidout, '%d %d %g ', res);
seq_id0 = max(seq_id);
end
fclose(fidin);
fclose(fidout);
quit
return;

function run_edit_distance_ranit(palfile,outfile)
fitfile = 'fit_21_025_1.txt'; %suitable for parameter alpha = 0.25
dicerfile='seqsd_hmdc257';
[seqsd,len] = read_seq(dicerfile);
%transform to string
length(seqsd)
for i = 1: length(seqsd)
    seqsd{i} = int2nuc(seqsd{i},'uppercase');
end
fidin = fopen(palfile,'r');
fidout = fopen(outfile,'w');
seqstot = 1000; %number of sequences to classify each loop
seq_id0 = 0;
while ~feof(fidin)
    disp('reading structure...');
    [seqs,bulges1,bulges2,endbulges,seq_id] = read_structure_fid(fidin, seqstot);

%transform back to string
for i = 1: length(seqs)
    seqs{i} = int2nuc(seqs{i},'uppercase');
end

```

```

[pos,score] = edit_predict(seqsd, seqs, endbulges)

%write to file
%seq_id0 is added so as to sequential order of sequence numbers
seq_id = seq_id + seq_id0;

% interpolate
[yside, yprec2] = interpolate_prob_new(score, fitfile);
res = [seq_id; pos; score; yprec2;yside];
fprintf(fidout, '%d %d %g %g %g\n', res);
seq_id0 = max(seq_id);
end
fclose(fidin);
fclose(fidout);
function [pos, score] = svm_position(x,svm_score,seqno, endbulges, lenp);
%[pos, score] = svm_position(x,svm_score, seqno, endbulges, lenp);
% postprocess svm outputs (for error analysis)
if size(x,1) ~= size(svm_score,1)
    error('x and svm_score not compatible');
end
if size(x,1) ~= size(seqno,1)
    error('x and seqno not compatible');
end
if max(seqno) ~= length(endbulges)
    error('seqno entries and endbulges size not compatible');
end
if length(lenp) ~= length(endbulges)
    error('lenp entries and endbulges size not compatible');
end
% use seqno to produce a list of boundaries between examples of different sequences
% this is important for efficiency (O(n) instead of O(n^2 log n))
ds = diff(seqno);
bnd = find(ds);
boundaries = [0 bnd' length(seqno)]; % examples of sequence i are between boundaries(i)+1 and boundaries(i+1)
for s = 1:max(seqno)
    l = boundaries(s)+1 : boundaries(s+1);
    [maxs,m] = max(svm_score(l));
    score(s) = maxs;

    seq_size = lenp(s);
    lb = find(endbulges{s});
    eb_size = length(lb);
    eb_begin = lb(1);
    eb_end = lb(eb_size);

    side = x(l(m),1);
    loopdist = x(l(m),2) * (0.5* (seq_size - eb_size));
    pos(s) = (1+side)/2*(eb_end + loopdist) + (1-side)/2*(eb_begin - loopdist);
end

```

```

pos = round(pos);
returnfunction [pos, score] = svm_position_r(x,svm_score,seqno, endbulges, lenp);
%[pos, score] = svm_position_r(x,svm_score, seqno, endbulges, lenp);
% postprocess svm outputs (for error analysis)
% regression version
if size(x,1) ~= size(svm_score,1)
    error('x and svm_score not compatible');
end
if size(x,1) ~= size(seqno,1)
    error('x and seqno not compatible');
end
if max(seqno) ~= length(endbulges)
    error('seqno entries and endbulges size not compatible');
end
if length(lenp) ~= length(endbulges)
    error('lenp entries and endbulges size not compatible');
end
% use seqno to produce a list of boundaries between examples of different sequences
% this is important for efficiency (O(n) instead of O(n^2 log n))
ds = diff(seqno);
bnd = find(ds);
boundaries = [0 bnd' length(seqno)]; % examples of sequence i are between boundaries(i)+1 and boundaries(i+1)
w = [-1.0 -0.5 0.0 0.5 1.0 0.5 0.0 -0.5 -1.0]; % window for convolution
nws = 0.5*(length(w)-1);
for s = 1:max(seqno)
    l = boundaries(s)+1 : boundaries(s+1);
    svm_scorel = svm_score(l);
    cnv = conv(w,svm_scorel);
    lcnv = length(cnv);
    % delete nws values on either side of cnv so that size equals that of scorel
    cnv([1:nws , lcnv-nws+1:lcnv]) = [];
    [maxs,m] = max(cnv);
    score(s) = maxs;

    seq_size = lenp(s);
    lb = find(endbulges{s});
    eb_size = length(lb);
    eb_begin = lb(1);
    eb_end = lb(eb_size);

    side = x(l(m),1);
    loopdist = x(l(m),2) * (0.5* (seq_size - eb_size));
    pos(s) = (1+side)/2*(eb_end + loopdist) + (1-side)/2*(eb_begin - loopdist);
end
pos = round(pos);
returnfunction [pos, score] = svm_position_soft(x,svm_score,seqno, endbulges, lenp);
%[pos, score] = svm_position_soft(x,svm_score, seqno, endbulges, lenp);
% postprocess svm outputs (for error analysis)
%
% takes the position closest to loop from positions which are at least

```

```

% best score - (1-Thresh)*abs(best score)
%
Thresh = 0.8;
if size(x,1) ~= size(svm_score,1)
    error('x and svm_score not compatible');
end
if size(x,1) ~= size(seqno,1)
    error('x and seqno not compatible');
end
if max(seqno) ~= length(endbulges)
    error('seqno entries and endbulges size not compatible');
end
if length(lenp) ~= length(endbulges)
    error('lenp entries and endbulges size not compatible');
end
% use seqno to produce a list of boundaries between examples of different sequences
% this is important for efficiency (O(n) instead of O(n^2 log n))
ds = diff(seqno);
bnd = find(ds);
boundaries = [0 bnd' length(seqno)]; % examples of sequence i are between boundaries(i)+1 and boundaries(i+1)
for s = 1:max(seqno)
    seq_size = lenp(s);
    lb = find(endbulges{s});
    eb_size = length(lb);
    eb_begin = lb(1);
    eb_end = lb(eb_size);

    l = boundaries(s)+1 : boundaries(s+1);

    maxs = max(svm_score(l));
    score(s) = maxs;
    m = find(svm_score(l) >= maxs - (1-Thresh)*abs(maxs));
    loopdist = x(l(m),2) * (0.5* (seq_size - eb_size));
    minlpdst = min(loopdist);
    lminloopdist = find(loopdist == minlpdst);
    m = m(lminloopdist);
    if length(m) > 1
        mscore = svm_score(l(m));
        [mxs,i] = max(mscore);
        m = m(i);
    end

    side = x(l(m),1);
    loopdist = x(l(m),2) * (0.5* (seq_size - eb_size));
    pos(s) = (1+side)/2*(eb_end + loopdist) + (1-side)/2*(eb_begin - loopdist);
end
pos = round(pos);
returnfunction [pos, score] = svm_position53(x5,svm_score5, seqno5, x3, svm_score3, seqno3, endbulges, lenp);
%[pos, score] = svm_position53(x5,svm_score5, seqno5, x3, svm_score3, seqno3, endbulges, lenp);
% postprocess svm outputs (for error analysis)

```

```

global Maxpos
method = 'bestn';
param = 1;
Maxpos = 10; % maximal number of positions returned
alpha5 = 0.6; alpha3 = 0.40; alpha_dlen = 0.4; % relative weights of 5 and 3 predictions
disp(['alpha5 alpha3 alpha_dlen' num2str(alpha5) ' ' ...
     num2str(alpha3) ' ' num2str(alpha_dlen)]);
if size(x5,1) ~= size(svm_score5,1)
    error('x5 and svm_score5 not compatible');
end
if size(x3,1) ~= size(svm_score3,1)
    error('x3 and svm_score3 not compatible');
end
if size(x5,1) ~= size(seqno5,1)
    error('x5 and seqno5 not compatible');
end
if size(x3,1) ~= size(seqno3,1)
    error('x3 and seqno3 not compatible');
end
if max(seqno5) ~= max(seqno3)
    error('seqno5 and seqno3 not compatible');
end
if max(seqno5) ~= length(endbulges)
    error('seqno entries and endbulges size not compatible');
end
if length(lenp) ~= length(endbulges)
    error('lenp entries and endbulges size not compatible');
end
fid = fopen('d:\rosetta\svm_light_utils1\dicer_length.out','r');
dlen = str2num(fgetl(fid));
pdlen = str2num(fgetl(fid));
fclose(fid);
dlenmin = min(dlen);
dlenmax = max(dlen);
scdlen = log(pdlen); % scale to score - heuristic!!!
scdlen = scdlen + mean(scdlen);
nseq = max(seqno5);
% use seqno to produce a list of boundaries between examples of different sequences
% this is important for efficiency (O(n) instead of O(n^2 log n))
ds5 = diff(seqno5);
bnd5 = find(ds5);
boundaries5 = [0 bnd5' length(seqno5)]; % examples of sequence i are between boundaries(i)+1 and boundaries(i+1)
ds3 = diff(seqno3);
bnd3 = find(ds3);
boundaries3 = [0 bnd3' length(seqno3)]; % examples of sequence i are between boundaries(i)+1 and boundaries(i+1)
if strcmp(method, 'bestn')
    pos = zeros(nseq,2*param);
    score = zeros(nseq,param);
elseif strcmp(method, 'best plus other side')
    pos = zeros(nseq,2*2);

```

```

    score = zeros(nseq,2);
else
    error('not supported yest');
end
for s = 1:max(seqno5)
    l5 = boundaries5(s)+1 : boundaries5(s+1);
    l3 = boundaries3(s)+1 : boundaries3(s+1);

    score5 = svm_score5(l5);
    score3 = svm_score3(l3);

    seq_size = lenp(s);
    lb = find(endbulges{s});
    eb_size = length(lb);
    eb_begin = lb(1);
    eb_end = lb(eb_size);

    side5 = x5(l5,1);
    loopdist5 = x5(l5,2) * (0.5* (seq_size - eb_size));
    pos5 = (1+side5)/2.*(eb_end + loopdist5) + (1-side5)/2.*(eb_begin - loopdist5);
    pos5 = round(pos5);

    side3 = x3(l3,1);
    loopdist3 = x3(l3,2) * (0.5* (seq_size - eb_size));
    pos3 = (1+side3)/2.*(eb_end + loopdist3) + (1-side3)/2.*(eb_begin - loopdist3);
    pos3 = round(pos3);
    % initialize. pos53(:,1) contains 5' position , pos53(:,1) contains 3' position
    pos53 = zeros(length(l5)*size(pdlen,2),2);
    score53 = zeros(length(l5)*size(pdlen,2),1);
    count = 0;
    for i = 1:length(pos5);
        pos5i = pos5(i);
        J = find(pos3 >= pos5i + dlenmin -1 & pos3 <= pos5i + dlenmax -1 & side3 == side5(i));
        for j = 1:length(J);
            count = count+1;
            pos53(count,:) = [pos5i , pos3(J(j))];
            ind = pos3(J(j))-pos5i -dlenmin +2;
            if ind < 1 | ind > size(scdlen,2)
                disp('error')
            end

            score53(count) = alpha5*score5(i) + alpha3*score3(J(j)) + alpha_dlen*scdlen(ind);
            %score53(count) = alpha5*tanh(score5(i)) + alpha3*tanh(score3(J(j))) + alpha_dlen*scdlen(ind);
            %score53(count) = max(score5(i),score3(J(j))) + alpha_dlen*scdlen(ind);
        end
    end
    % now pick the desired positions for each sequence ,
    % e.g. 'best' , 'best plus other side', 'above thresh' 'percentile'.
    l = find(pos53(:,1) == 0);
    pos53(l,:) = [];

```

```

score53(l) = [];
if isempty(score53)
    error('empty score53');
end

[poss, scores] = choose_pos_score(pos53,score53, eb_begin, method, param);
pos(s,:) = poss;
score(s,:) = scores;
if mod(s,1000) == 0
    disp([num2str(s)])
end
end
return
function [pos, score] = choose_pos_score(pos53,score53, eb_begin, method, param)
% auxiliary function
if strcmp(method, 'bestn')
    nbest = param;
    [s,l] = sort(-score53);
    pos(1:nbest,:) = pos53(l(1:nbest),:);
    score(1:nbest) = score53(l(1:nbest));
    pos = pos';
    pos = pos(:);
    pos = pos';
    score = score';
elseif strcmp(method, 'best plus other side')
    pos = zeros(2,2);
    score = zeros(1,2);

    [mx,i] = max(score53);
    pos(1,:) = pos53(i,:);
    score(1) = score53(i);

    Os = find( (pos53(:,1)-eb_begin) * (pos(1,1) -eb_begin) < 0); %Other side
    if ~isempty(Os)
        [mx,i] = max(score53(Os));
        pos(2,:) = pos53(Os(i),:);
        score(2) = score53(Os(i));
    else
        % this may hapen when the sequence on other side was too short.
        pos(2,:) = NaN;
        score(2) = NaN;
    end
elseif strcmp(method, 'percentile')
    perc = params;
    if perc < 1
        perc = perc*100;
    end
    xp = prctile(score53, perc);
    l = find(score53 >= xp);
    [s,J] = sort(-score53(l));

```

```

J = l(J);
score = score53(l);
pos = pos53(l,:);
else
    error('method not implemented');
end
returnfunction [pos, score] = svm_position53h(x5,svm_score5, seqno5, x3, svm_score3, seqno3, endbulges, lenp);
%[pos, score] = svm_position53h(x5,svm_score5, seqno5, x3, svm_score3, seqno3, endbulges, lenp);
% postprocess svm outputs (for error analysis)
% hard limiter on results of classifier on 3'
global Maxpos
method = 'bestn';
param = 1;
Maxpos = 10; % maximal number of positions returned
alpha5 = 0.6; alpha3 = 0.40; alpha_dlen = 0.4; % relative weights of 5 and 3 predictions
disp(['alpha5 alpha3 alpha_dlen' num2str(alpha5) ' ' ...
    num2str(alpha3) ' ' num2str(alpha_dlen)]);
if size(x5,1) ~= size(svm_score5,1)
    error('x5 and svm_score5 not compatible');
end
if size(x3,1) ~= size(svm_score3,1)
    error('x3 and svm_score3 not compatible');
end
if size(x5,1) ~= size(seqno5,1)
    error('x5 and seqno5 not compatible');
end
if size(x3,1) ~= size(seqno3,1)
    error('x3 and seqno3 not compatible');
end
if max(seqno5) ~= max(seqno3)
    error('seqno5 and seqno3 not compatible');
end
if max(seqno5) ~= length(endbulges)
    error('seqno entries and endbulges size not compatible');
end
if length(lenp) ~= length(endbulges)
    error('lenp entries and endbulges size not compatible');
end
fid = fopen('d:\rosetta\svm_light_utils1\dicer_length.out','r');
dlen = str2num(fgetl(fid));
pdlen = str2num(fgetl(fid));
fclose(fid);
dlenmin = min(dlen);
dlenmax = max(dlen);
scdlen = log(pdlen); % scale to score - heuristic!!!
scdlen = scdlen + mean(scdlen);
nseq = max(seqno5);
% use seqno to produce a list of boundaries between examples of different sequences
% this is important for efficiency (O(n) instead of O(n^2 log n))
ds5 = diff(seqno5);

```

```

bnd5 = find(ds5);
boundaries5 = [0 bnd5' length(seqno5)]; % examples of sequence i are between boundaries(i)+1 and boundaries(i+1)
ds3 = diff(seqno3);
bnd3 = find(ds3);
boundaries3 = [0 bnd3' length(seqno3)]; % examples of sequence i are between boundaries(i)+1 and boundaries(i+1)
if strcmp(method, 'bestn')
    pos = zeros(nseq,param);
    score = zeros(nseq,param);
elseif strcmp(method, 'best plus other side')
    pos = zeros(nseq,2);
    score = zeros(nseq,2);
else
    error('not supported yest');
end
for s = 1:max(seqno5)
    I5 = boundaries5(s)+1 : boundaries5(s+1);
    I3 = boundaries3(s)+1 : boundaries3(s+1);

    score5 = svm_score5(I5);
    score3 = svm_score3(I3);

    seq_size = lenp(s);
    lb = find(endbulges{s});
    eb_size = length(lb);
    eb_begin = lb(1);
    eb_end = lb(eb_size);

    side5 = x5(I5,1);
    loopdist5 = x5(I5,2) * (0.5* (seq_size - eb_size));
    pos5 = (1+side5)/2.*(eb_end + loopdist5) + (1-side5)/2.*(eb_begin - loopdist5);
    pos5 = round(pos5);

    if max(score3 < -0.1)
        [maxs,m] = max(svm_score5);
        score(s) = maxs;
        pos(s) = pos5(m);
    else
        side3 = x3(I3,1);
        loopdist3 = x3(I3,2) * (0.5* (seq_size - eb_size));
        pos3 = (1+side3)/2.*(eb_end + loopdist3) + (1-side3)/2.*(eb_begin - loopdist3);
        pos3 = round(pos3);
    % initialize. pos53(:,1) contains 5' position , pos53(:,1) contains 3' position
    pos53 = zeros(length(I5)*size(pdlen,2),1);
    score53 = zeros(length(I5)*size(pdlen,2),1);
    count = 0;
    for i = 1:length(pos5);
        pos5i = pos5(i);
        J = find(pos3 >= pos5i + dlenmin -1 & pos3 <= pos5i + dlenmax -1 & side3 == side5(i));
        for j = 1:length(J);
            count = count+1;

```

```

    pos53(count,:) = pos5i;
    ind = pos3(J(j))-pos5i -dlenmin +2;
    if ind < 1 | ind > size(scdlen,2)
        disp('error')
    end

    score53(count) = alpha5*score5(i) + alpha3*score3(J(j)) + alpha_dlen*scdlen(ind);
end
end
% now pick the desired positions for each sequence ,
% e.g. 'best' , 'best plus other side', 'above thresh' 'percentile'.
I = find(pos53(:,1) == 0);
pos53(I) = [];
score53(I) = [];
if isempty(score53)
    error('empty score53');
end

[poss, scores] = choose_pos_score(pos53,score53, eb_begin, method, param);
pos(s,:) = poss;
score(s,:) = scores;
if mod(s,1000) == 0
    disp([num2str(s)])
end
end
end
return
function [pos, score] = choose_pos_score(pos53,score53, eb_begin, method, param)
% auxiliary function
if strcmp(method, 'bestn')
    nbest = param;
    [s,I] = sort(-score53);
    pos(1:nbest) = pos53(I(1:nbest));
    score(1:nbest) = score53(I(1:nbest));
    pos = pos';
    score = score';
elseif strcmp(method, 'best plus other side')
    pos = zeros(1,2);
    score = zeros(1,2);

    [mx,i] = max(score53);
    pos(1) = pos53(i);
    score(1) = score53(i);

    Os = find( (pos53(:,1)-eb_begin) * (pos(1,1) -eb_begin) < 0); %Other side
    if ~isempty(Os)
        [mx,i] = max(score53(Os));
        pos(2) = pos53(Os(i));
        score(2) = score53(Os(i));
    else

```

```

        % this may hapen when the sequence on other side was too short.
        pos(2) = NaN;
        score(2) = NaN;
    end
elseif strcmp(method, 'percentile')
    perc = params;
    if perc < 1
        perc = perc*100;
    end
    xp = prctile(score53, perc);
    I = find(score53 >= xp);
    [s,J] = sort(-score53(I));
    J = I(J);
    score = score53(I);
    pos = pos53(I );
else
    error('method not implemented');
end
returnfunction svm_predict(infile,outfile);
%svm_predict(infile,outfile);
%perform svm position prediction
svm_light_folder = 'C:/svm/bin/';
model_filename5 = [svm_light_folder 'model5-2-6-2-6-21'];
tst_filename5 = 'C:/svm/Temp/svm_tst_5.dat';
svm_out_filename5 = 'C:/svm/Temp/out5.out';
fit_filename = 'C:/svm/Score/fit_p5-2-6-2-6-21.txt';
[seqs,bulges1,bulges2,endbulges,seq_id] = read_structure(infile);

[x5, seqno5] = preprocess_and_write_data5(seqs,bulges1, ...
    bulges2,endbulges, tst_filename5);
dos([svm_light_folder 'svm_classify ' tst_filename5 ' ' model_filename5 ' ' svm_out_filename5]);
% load and postprocess
curdir=pwd;
cd 'c:/svm/temp'
load out5.out;
cd(curdir);
lenp = length_seq(seqs);
[pos5, score5] = svm_position(x5,out5, seqno5, endbulges, lenp);
% infer probabilities
[yside, yprec2] = interpolate_prob_new(score5, fit_filename);
%write to file
res = [seq_id; pos5; score5; yprec2; yside];
fid = fopen(outfile,'w');
fprintf(fid, '%d %d %g %g %g\n', res);
fclose(fid);
function svm_predict();
%svm_predict_b(infile,outfile);
%perform svm position prediction
% version for large input files
% reads seqtot sequences at a time and classifies them

```

```

infile='c:\svm\in\draw_file.dat';
outfile='c:\svm\out\dicer_res.dat';
cd \\rosetta4\Development\gideon\svm\util
svm_light_folder = 'C:/svm/bin/';
model_filename5 = [svm_light_folder 'model5-2-6-2-6-21'];
tst_filename5 = 'C:/svm/Temp/svm_tst_5.dat';
svm_out_filename5 = 'C:/svm/Temp/out5.out';
fit_filename = 'C:/svm/Score/fit_p5-2-6-2-6-21.txt';
fidin = fopen(infile,'r');
fidout = fopen(outfile,'w');
seqstot = 1000; %number of sequences to classify each loop
seq_id0 = 0;
while ~feof(fidin)
    disp('reading structure...');
    [seqs,bulges1,bulges2,endbulges,seq_id] = read_structure_fid(fidin, seqstot);
    lenp = length_seq(seqs);

    disp('preprocessing and writing...');
    [x5, seqno5] = preprocess_and_write_data5(seqs,bulges1, ...
        bulges2,endbulges, tst_filename5);
    cd c:\
    dos([svm_light_folder 'svm_classify ' tst_filename5 ' ' model_filename5 ' ' svm_out_filename5]);
    cd \\rosetta4\Development\gideon\svm\util
% load and postprocess
fidsvm = fopen(svm_out_filename5,'r');
out5 = fscanf(fidsvm, '%g');
fclose(fidsvm);

    disp('postprocessing...');
    [pos5, score5] = svm_position(x5,out5, seqno5, endbulges, lenp);
% infer probabilities
    [yside, yprec2] = interpolate_prob_new(score5, fit_filename);
%write to file
%seq_id0 is added so as to sequential order of sequence numbers
    seq_id = seq_id + seq_id0;
    res = [seq_id; pos5; score5; yprec2; yside];
    fprintf(fidout, '%d %d %g %g %g ', res);
    seq_id0 = max(seq_id);
end
fclose(fidin);
fclose(fidout);
quit
function svm_predict_b(infile,outfile);
%svm_predict_b(infile,outfile);
%perform svm position prediction
% version for large input files
% reads seqtot sequences at a time and classifies them
svm_light_folder = 'C:/svm/bin/';
model_filename5 = [svm_light_folder 'model5-2-6-2-6-21'];
tst_filename5 = 'C:/svm/Temp/svm_tst_5.dat';

```

```

svm_out_filename5 = 'C:/svm/Temp/out5.out';
fit_filename = 'C:/svm/Score/fit_p5-2-6-2-6-21.txt';
fidin = fopen(infile,'r');
fidout = fopen(outfile,'w');
seqstot = 1000; %number of sequences to classify each loop
seq_id0 = 0;
while ~feof(fidin)
    disp('reading structure...');
    [seqs,bulges1,bulges2,endbulges,seq_id] = read_structure_fid(fidin, seqstot);
    lenp = length_seq(seqs);

    disp('preprocessing and writing...');
    [x5, seqno5] = preprocess_and_write_data5(seqs,bulges1, ...
        bulges2,endbulges, tst_filename5);
    dos([svm_light_folder 'svm_classify ' tst_filename5 ' ' model_filename5 ' ' svm_out_filename5]);
% load and postprocess
    fidsvm = fopen(svm_out_filename5,'r');
    out5 = fscanf(fidsvm, '%g');
    fclose(fidsvm);

    disp('postprocessing...');
    [pos5, score5] = svm_position(x5,out5, seqno5, endbulges, lenp);
% infer probabilities
    [yside, yprec2] = interpolate_prob_new(score5, fit_filename);
%write to file
%seq_id0 is added so as to sequential order of sequence numbers
    seq_id = seq_id + seq_id0;
    res = [seq_id; pos5; score5; yprec2; yside];
    fprintf(fidout, '%d %d %g %g %g\n', res);
    seq_id0 = max(seq_id);
end
fclose(fidin);
fclose(fidout);
function unique_seqs(seqs,seqsd,bulges1, bulges2, endbulges, lenp, lend, pos, seq_id)
[y,l] = sort(lenp);
bulges1 = bulges1(l);
bulges2 = bulges2(l);
endbulges = endbulges(l);
lend = lend(l);
lenp = lenp(l);
pos = pos(l);
seq_id = seq_id(l);
seqs = seqs(l);
seqsd = seqsd(l);

count = 1;
lc(count) = 1;
for i = 2:length(seqs)
    if lenp(i) == lenp(i-1)
        if any(seqs{i} ~= seqs{i-1})

```

```

        count = count+1;
        lc(count) = i;
    end
else
    count = count+1;
    lc(count) = i;
end
end

keyboard

function write_examples(xi,yi, fid);
% %low level function
% write examples in format compatible with svm light
% xi,yi are the example vector + targets
% in testing mode the yi's are set to 0
for j = 1:size(xi,1)
    fprintf(fid,'%d',yi(j));
    l = find(xi(j,:));
    xprint = [l;xi(j,l)];
    fprintf(fid,' %d:%g',xprint);
    fprintf(fid,'\n');
endfunction write_examples_simple(xi,yi, fid);
% %low level function
% write examples in format compatible with svm light
% xi,yi are the example vector + targets
% in testing mode the yi's are set to 0
for j = 1:size(xi,1)
    fprintf(fid,'%d',yi(j));
    fprintf(fid,' %g',xi);
    fprintf(fid,'\n');
end
kkk = 1:6000;
[x12_5, seqno_5] =
preprocess_and_write_data5(seqs(kk),bulges1(kk),bulges2(kk),endbulges(kk),'g:\research\rosetta\svm_light_utils1\sv
m_preprocessed\svm5_kk1.dat');
[x12_3, seqno_3] =
preprocess_and_write_data5(seqs(kk),bulges1(kk),bulges2(kk),endbulges(kk),'g:\research\rosetta\svm_light_utils1\sv
m_preprocessed\svm3_kk1.dat');
% use svm light to classify both each ewth its own model
load output5_kk1.out
load output3_kk1.out
[pos53kk, score53kk] = svm_position53(x12_5,output5_kk1, seqno_5, x12_3, output3_kk1, seqno_3, endbulges(kk),
lenp(kk));
%write final results to file
res = [seq_id(kk); pos53kk(:,1)'; pos53kk(:,2)'; score53kk'];
fid = fopen('res53_33156.out','a');
fprintf(fid, '%d %d %d %g\n', res);
fclose(fid);

```

```

function [first_pos,first_score] = firstk_determine(seqsd,seqs, pos1, pos2,ktup,k,range);
%[first_pos,first_score] = firstk_determine(seqsd,seqs, pos1, pos2,ktup,k,range);
%for each%for each palindrome with two mir predictions - which is better
%search on -2+2 positions on each side for the best firstk score
if nargin ==4
    model.ktup = 8;
    model.k = 1;
    model.range = -2:2;
else
    model.ktup = ktup;
    model.k = k;
    model.range = range;
end
model.beta = 2;
model.use_min = 0;
first_pos = zeros(size(seqs));
first_score = zeros(size(seqs));
for i = 1:length(seqs)
    if mod(i,100) == 0, fprintf('..%d',i);end
    [first_pos(i), first_score(i)] = firstk_determine1(seqsd,seqs{i}, pos1(i), pos2(i), model);
end
fprintf('\n');
return
function [first_posi, first_scorei] = firstk_determine1(seqsd,seqsi, pos1i, pos2i,model);
k = model.k;
ktup = model.ktup;
beta = model.beta;
range = model.range;
%around pos1
for i = 1:length(range)
    posi = pos1i+range(i);
    if posi >0 & posi +ktup <= length(seqsi)
        p = seqsi(posi:posi+ktup-1);
        for j = 1:length(seqsd)
            d(j) = editD(p,seqsd{j})(1:ktup));
        end
        min_d1(i) = min(d);
        % take also the mean of highest percentile
        [ds,l] = sort(d);
        mean_d1(i) = mean(ds(1:k));
    else
        mean_d1(i) = nan;
    end
end
end
max1 = 1-min(mean_d1)/ktup;
%around pos2
for i = 1:length(range)
    posi = pos2i+range(i);
    if posi >0 & posi +ktup <= length(seqsi)
        p = seqsi(posi:posi+ktup-1);

```

```

for j = 1:length(seqsd)
    d(j) = editD(p,seqsd{j})(1:ktup));
end
min_d2(i) = min(d);
% take also the mean of highest percentile
[ds,l] = sort(d);
    mean_d2(i) = mean(ds(1:k));
else
    mean_d2(i) = nan;
end
end
max2 = 1-min(mean_d2)/ktup;
if max1 > max2
    %first_posi = pos1i;
    first_posi = 1;
    first_scorei = max1;
elseif max2 > max1
    %first_posi = pos2i;
    first_posi = 2;
    first_scorei = max2;
else
    if model.use_min
        if min(min_d1) == min(min_d2)
            first_posi = nan;
            first_scorei = nan;
        elseif min(min_d1) < min(min_d2)
            first_posi = 1;
            first_scorei = 0;
        else
            first_posi = 2;
            first_scorei = 0;
        end
    else
        first_posi = nan;
        first_scorei = nan;
    end %if model.use_min
end
return
load vars_hmdc440
seqs = palseq;
seqsd = mirseq;
pos = mirpos;
lend = mirlen;
clear palseq mirseq mirpos mirlen curdir datadir
function [id, palgrade5, pal_seq, pos1, pos2, score] = read_table_res(filename)
%[id, palgrade5, pal_seq, pos1, pos2, score] = read_table_res(filename)
fid = fopen(filename,'r');
k = 1;
while ~feof(fid);
    if (mod(k,100) == 0) fprintf('.'); end

```

```

line = fgetl(fid);
if line(1) ~= '%'
    [t,r] = strtok(line);
    id(k) = str2num(t);
    [t,r] = strtok(r);
    palgrade5(k) = str2num(t);
    [t,r] = strtok(r);
    pal_seq{k} = t;
    [t,r] = strtok(r);
    pos1(k) = str2num(t);
    [t,r] = strtok(r);
    pos2(k) = str2num(t);
    [t,r] = strtok(r);
    score(k) = str2num(t);
    k = k+1;
end
end
fclose(fid);
return
function run_firstk_side_determine(filein, fileout)
%run_firstk_side_determine(filein, fileout)
%determine the better side of palgrade predictions, based of firstk
[id, palgrade5, pal_seq, pos1, pos2, score] = read_table_res(filein);
disp(['read ' num2str(length(id)) ' records']);
load_all;
seqsd_all = transform_format(seqsd);
%remove records with nan positions
l = find(isnan(pos1) | isnan(pos2));
id(l) = [];
palgrade5(l) = [];
pal_seq(l) = [];
pos1(l) = [];
pos2(l) = [];
score(l) = [];
disp([num2str(length(id)) ' non null records passed to firstk_determine']);
fid = fopen(fileout,'w');
[first_pos,first_score] = firstk_determine(seqsd_all,pal_seq, pos1, pos2,10, 3, -1:1);
res = [id; first_pos; first_score];
fprintf(fid, '%d %d %5.3f\n',res);
fclose(fid);
return

```

```

function mfe = anti_inds_to_mfe(anti_inds)
% anti_inds holds for each nuc in the seq what is the index of
% the nuc across from it where the 0 means unpaired (this is returned by read_structure_withanti).
% returns mfe which is the structure in the format of rnafold, i.e. only base pairs:
% mfe is a 2 col matrix, the first being the bases on arm5 which are paired and the second
% their corresponding pairs
if(~iscell(anti_inds))
    mfe = get_mfe(anti_inds);
    return;
end
for i=1:length(anti_inds)
    mfe{i} = get_mfe(anti_inds{i});
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function mfe = get_mfe(ai)
bps=0;
for i=1:length(ai)
    if(ai(i))
        if(i>ai(i))
            return
        end
        bps = bps+1;
        mfe(bps,1) = i;
        mfe(bps,2) = ai(i);
    end
end
mfold_cv_proto;
score(examples) = win_score(examples).*pos_score(examples);
%score(examples) = pos_score(examples);
figure
subplot(2,1,1)
res = analyse_errors_perc(pos_est(examples),score(examples),mirpos(examples),endbulges(examples));
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
subplot(2,1,2)
if(~exist('num_bins'))
    num_bins = 6;
end
[xs,ys,xp2,yp2] =
analyse_errors_bins2(pos_est(examples),score(examples),mirpos(examples),endbulges(examples),num_bins);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
mfold_cv_proto;
%score(examples) = win_score(examples).*pos_score(examples);
score(examples) = win_score(examples);
%score(examples) = pos_score(examples);
for i=1:length(mirpos)
    mfe = mfes{i};
    pos_est_arm5(i) = max(1,(mfe(win_pos_est(i),1) - model.win_len + 1));

```

```

pos_est_arm3(i) = mfe(win_pos_est(i),2);
d5 = abs(pos_est_arm5(i)-mirpos(i));
d3 = abs(pos_est_arm3(i)-mirpos(i));
pos_error(i) = min(d5,d3);
if(d3<d5)
    pos_est_side_known(i) = pos_est_arm3(i);
else
    pos_est_side_known(i) = pos_est_arm5(i);
end
end
figure
subplot(2,1,1)
res = analyse_errors_perc(pos_est(examples),score(examples),mirpos(examples),endbulges(examples));
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
subplot(2,1,2)
if(~exist('num_bins'))
    num_bins = 6;
end
[xs,ys,xp2,yp2] =
analyse_errors_bins2(pos_est(examples),score(examples),mirpos(examples),endbulges(examples),num_bins);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
figure
subplot(2,1,1)
res =
analyse_errors_perc(pos_est_side_known(examples),score(examples),mirpos(examples),endbulges(examples));
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
subplot(2,1,2)
if(~exist('num_bins'))
    num_bins = 6;
end
[xs,ys,xp2,yp2] =
analyse_errors_bins2(pos_est_side_known(examples),score(examples),mirpos(examples),endbulges(examples),num
_bins);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
save_mfold_data = 1;
filename = 'mfold_rand5_rundata.mat';
randstate=5;
mfold_cv_random;
%score = win_score.*pos_score;
score = win_score;
%score = pos_score;
figure
subplot(2,1,1)
res = analyse_errors_perc(pos_est,score,mirpos,endbulges);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')

```

```

subplot(2,1,2)
if(~exist('num_bins'))
    num_bins = 6;
end
[xs,ys,xp2,yp2] = analyse_errors_bins2(pos_est,score,mirpos,endbulges,num_bins);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
if(save_mfold_data)
    eval(['save ' filename]);
end
mfold_cv_random;
%score = win_score.*pos_score;
score = win_score;
%score = pos_score;
for i=1:length(mirpos)
    mfe = mfes{i};
    pos_est_arm5(i) = max(1,(mfe(win_pos_est(i),1) - model.win_len + 1));
    pos_est_arm3(i) = mfe(win_pos_est(i),2);
    d5 = abs(pos_est_arm5(i)-mirpos(i));
    d3 = abs(pos_est_arm3(i)-mirpos(i));
    pos_error(i) = min(d5,d3);
    if(d3<d5)
        pos_est_side_known(i) = pos_est_arm3(i);
    else
        pos_est_side_known(i) = pos_est_arm5(i);
    end
end
figure
subplot(2,1,1)
res = analyse_errors_perc(pos_est,score,mirpos,endbulges);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
subplot(2,1,2)
if(~exist('num_bins'))
    num_bins = 6;
end
[xs,ys,xp2,yp2] = analyse_errors_bins2(pos_est,score,mirpos,endbulges,num_bins);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
figure
subplot(2,1,1)
res = analyse_errors_perc(pos_est_side_known,score,mirpos,endbulges);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
subplot(2,1,2)
if(~exist('num_bins'))
    num_bins = 6;
end
[xs,ys,xp2,yp2] = analyse_errors_bins2(pos_est_side_known,score,mirpos,endbulges,num_bins);
a=axis; a(3)=0; a(4)=1; axis(a); grid;

```

```

legend('off')
mfold_cv_testwin_proto;
% chooses the correct side to only test win prediction and not side prediction
for i=1:length(examples)
    ind = examples(i);
    mfe = mfes{ind};
    pos_est_arm5 = max(1,(mfe(win_pos_est(i),1) - model.win_len + 1));
    pos_est_arm3 = mfe(win_pos_est(ind),2);
    d5 = abs(pos_est_arm5-mirpos(ind));
    d3 = abs(pos_est_arm3-mirpos(ind));
    pos_error(ind) = min(d5,d3);
    if(d3<d5)
        pos_est(ind) = pos_est_arm3;
    else
        pos_est(ind) = pos_est_arm5;
    end
end
figure
subplot(2,1,1)
res = analyse_errors_perc(pos_est(examples),win_score(examples),mirpos(examples),endbulges(examples));
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
subplot(2,1,2)
if(~exist('num_bins'))
    num_bins = 6;
end
[xs,ys,xp2,yp2] =
analyse_errors_bins2(pos_est(examples),win_score(examples),mirpos(examples),endbulges(examples),num_bins);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
mfold_cv_testwin_random;
% chooses the correct side to only test win prediction and not side prediction
for i=1:length(mirpos)
    mfe = mfes{i};
    pos_est_arm5 = max(1,(mfe(win_pos_est(i),1) - model.win_len + 1));
    pos_est_arm3 = mfe(win_pos_est(i),2);
    d5 = abs(pos_est_arm5-mirpos(i));
    d3 = abs(pos_est_arm3-mirpos(i));
    pos_error(i) = min(d5,d3);
    if(d3<d5)
        pos_est(i) = pos_est_arm3;
    else
        pos_est(i) = pos_est_arm5;
    end
end
figure
subplot(2,1,1)
res = analyse_errors_perc(pos_est,win_score,mirpos,endbulges);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')

```

```

subplot(2,1,2)
if(~exist('num_bins'))
    num_bins = 6;
end
[xs,ys,yp2,yp2] = analyse_errors_bins2(pos_est,win_score,mirpos,endbulges,num_bins);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
function model = bayes_learn_pos_given_win(seqs,anti_inds,bulges1,bulges2,endbulges,pos,mirlen,model)
%model is a struct.
% mfes{i} holds the structure in the basepair notation
mfes = anti_inds_to_mfe(anti_inds);
% win_pos(i) is the position of the window corresponding to mir i
win_pos = get_win_pos_v1(mfes,anti_inds,pos,mirlen);
possible_positions = get_possible_positions(model,mfes,endbulges,win_pos);
% for each seq hold the mirposition and all possible positions that are not mirpos
for i=1:length(pos)
    mirpos(i) = pos(i);
    nonmirpos{i} = setdiff(possible_positions{i},mirpos(i));
end
[upper_mean_dist,upper_std_dist,lower_mean_dist,lower_std_dist] = loopdist_model(mirpos,endbulges);
model.pos_upper_mean_dist = upper_mean_dist;
model.pos_upper_std_dist = upper_std_dist;
model.pos_lower_mean_dist = lower_mean_dist;
model.pos_lower_std_dist = lower_std_dist;
[p1_nuc_mir,p2_nuc_mir]= nucleotide_pos_model_list(model,seqs,mirpos);
[p1_nuc_nonmir,p2_nuc_nonmir]= nucleotide_pos_model_list(model,seqs,nonmirpos);
model.pos_p1_nuc_mir = p1_nuc_mir;
model.pos_p2_nuc_mir = p2_nuc_mir;
model.pos_p1_nuc_nonmir = p1_nuc_nonmir;
model.pos_p2_nuc_nonmir = p2_nuc_nonmir;
[pb1_mir,pb2_mir,pbtot_mir] = pos_bulge_pos_model_list(model,bulges1,bulges2,mirpos);
[pb1_nonmir,pb2_nonmir,pbtot_nonmir] = pos_bulge_pos_model_list(model,bulges1,bulges2,nonmirpos);
model.pos_pb1_mir = pb1_mir;
model.pos_pb1_nonmir = pb1_nonmir;
model.pos_pb2_mir = pb2_mir;
model.pos_pb2_nonmir = pb2_nonmir;
model.pos_pbtot_mir = pbtot_mir;
model.pos_pbtot_nonmir = pbtot_nonmir;
p_bp_mir = pos_base_pair_model_list(model,seqs,anti_inds,mirpos);
p_bp_nonmir = pos_base_pair_model_list(model,seqs,anti_inds,nonmirpos);
model.p_bp_mir = p_bp_mir;
model.p_bp_nonmir = p_bp_nonmir;
function model = bayes_learn_win(seqs,anti_inds,bulges1,bulges2,endbulges,pos,mirlen,model)
%model_params is a struct.
% mfes{i} holds the structure in the basepair notation
mfes = anti_inds_to_mfe(anti_inds);
% win_pos(i) is the position of the window corresponding to mir i
win_pos = get_win_pos_v1(mfes,anti_inds,pos,mirlen);
% for each seq hold the mirposition and all possible positions that are not mirpos
for i=1:length(pos)

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mirwin(i) = win_pos(i);
n_bps = size(mfes{i},1);
nonmirwin{i} = setdiff([model.min_win_bp:n_bps],mirwin(i));
end
[mean_loopdist,std_loopdist] = loopdist_bp_model_normal(win_pos,mfes);
model.mean_loopdist_bp = mean_loopdist;
model.std_loopdist_bp = std_loopdist;
[win_num_bps_mir_vals,win_num_bps_mir_ps] = num_bps_model_hist_list(mfes,anti_inds,model,mirwin);
[win_num_bps_nonmir_vals,win_num_bps_nonmir_ps] = num_bps_model_hist_list(mfes,anti_inds,model,nonmirwin);
model.win_num_bps_mir_vals = win_num_bps_mir_vals;
model.win_num_bps_mir_ps = win_num_bps_mir_ps;
model.win_num_bps_nonmir_vals = win_num_bps_nonmir_vals;
model.win_num_bps_nonmir_ps = win_num_bps_nonmir_ps;
[win_sym_mir_vals,win_sym_mir_ps] = win_sym_model_list(mfes,anti_inds,model,mirwin);
[win_sym_nonmir_vals,win_sym_nonmir_ps] = win_sym_model_list(mfes,anti_inds,model,nonmirwin);
model.win_sym_mir_vals = win_sym_mir_vals;
model.win_sym_mir_ps = win_sym_mir_ps;
model.win_sym_nonmir_vals = win_sym_nonmir_vals;
model.win_sym_nonmir_ps = win_sym_nonmir_ps;
[pb_arm5_mir,pb_arm3_mir,pb1_arm5_mir,pb1_arm3_mir,pb2_arm5_mir,pb2_arm3_mir]...
    = win_bulge_pos_model_list(mfes,bulges1,bulges2,model,mirwin);
[pb_arm5_nonmir,pb_arm3_nonmir,pb1_arm5_nonmir,pb1_arm3_nonmir,pb2_arm5_nonmir,pb2_arm3_nonmir]...
    = win_bulge_pos_model_list(mfes,bulges1,bulges2,model,nonmirwin);
model.win_bulge_posit_arm5_mir = pb_arm5_mir;
model.win_bulge_posit_arm3_mir = pb_arm3_mir;
model.win_bulge1_posit_arm5_mir = pb1_arm5_mir;
model.win_bulge1_posit_arm3_mir = pb1_arm3_mir;
model.win_bulge2_posit_arm5_mir = pb2_arm5_mir;
model.win_bulge2_posit_arm3_mir = pb2_arm3_mir;
model.win_bulge_posit_arm5_nonmir = pb_arm5_nonmir;
model.win_bulge_posit_arm3_nonmir = pb_arm3_nonmir;
model.win_bulge1_posit_arm5_nonmir = pb1_arm5_nonmir;
model.win_bulge1_posit_arm3_nonmir = pb1_arm3_nonmir;
model.win_bulge2_posit_arm5_nonmir = pb2_arm5_nonmir;
model.win_bulge2_posit_arm3_nonmir = pb2_arm3_nonmir;
[win_p_bp_arm5_mir,win_p_bp_arm3_mir] = ...
    win_base_pair_model_list(mfes,anti_inds,seqs,model,mirwin);
[win_p_bp_arm5_nonmir,win_p_bp_arm3_nonmir] = ...
    win_base_pair_model_list(mfes,anti_inds,seqs,model,nonmirwin);
model.win_base_pair_arm5_mir = win_p_bp_arm5_mir;
model.win_base_pair_arm3_mir = win_p_bp_arm3_mir;
model.win_base_pair_arm5_nonmir = win_p_bp_arm5_nonmir;
model.win_base_pair_arm3_nonmir = win_p_bp_arm3_nonmir;
[p1_5_mir,p2_5_mir,p1_3_mir,p2_3_mir] = win_nuc_positional_model_list(seqs,mfes,model,mirwin);
[p1_5_nonmir,p2_5_nonmir,p1_3_nonmir,p2_3_nonmir] = ...
    win_nuc_positional_model_list(seqs,mfes,model,nonmirwin);
model.win_nuc_pos_p1_5_mir = p1_5_mir;
model.win_nuc_pos_p2_5_mir = p2_5_mir;
model.win_nuc_pos_p1_3_mir = p1_3_mir;
model.win_nuc_pos_p2_3_mir = p2_3_mir;

```

```

model.win_nuc_pos_p1_5_nonmir = p1_5_nonmir;
model.win_nuc_pos_p2_5_nonmir = p2_5_nonmir;
model.win_nuc_pos_p1_3_nonmir = p1_3_nonmir;
model.win_nuc_pos_p2_3_nonmir = p2_3_nonmir;
return
function [pos,score] = bayes_predict_pos_given_win(seqs,win_pos,anti_inds,bulges1,bulges2,endbulges,model)
mfes = anti_inds_to_mfe(anti_inds);
for i = 1:length(seqs)
    %disp(num2str(i));
    [posi, scorei] =
bayes_predict_side_i(model,seqs{i},win_pos(i),mfes{i},anti_inds{i},bulges1{i},bulges2{i},endbulges{i});
    pos(i) = posi;
    score(i) = scorei;
end
return
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [posi, scorei] = bayes_predict_side_i(model,seqsi,wp,mfei,ai,bulges1i,bulges2i,endbulgesi)
pl = get_possible_positions(model,mfei,endbulgesi,wp);
pos_list = pl{1};
p_loopdist = loopdist_prob(pos_list,model,endbulgesi);
[p_pos_nuc_mir,p_pos_nuc_nonmir] = nuc_pos_prob(pos_list,model,seqsi);
[p_pos_bulge_mir,p_pos_bulge_nonmir] = bulge_pos_prob(pos_list,model,bulges1i,bulges2i);
[p_base_pair_mir,p_base_pair_nonmir] = base_pair_prob(pos_list,model,seqsi,ai);
p_mir = ones(size(pos_list));
p_nonmir = ones(size(pos_list));
if(model.pos_use_loopdist)
    p_mir = p_mir.*p_loopdist;
    p_nonmir = p_nonmir.*(1-p_loopdist);
end
if(model.pos_use_pos_nuc)
    p_mir = p_mir.*p_pos_nuc_mir;
    p_nonmir = p_nonmir.*p_pos_nuc_nonmir;
end
if(model.pos_use_pos_bulge)
    p_mir = p_mir.*p_pos_bulge_mir;
    p_nonmir = p_nonmir.*p_pos_bulge_nonmir;
end
if(model.pos_use_base_pair)
    p_mir = p_mir.*p_base_pair_mir;
    p_nonmir = p_nonmir.*p_base_pair_nonmir;
end
I = find((p_mir + p_nonmir) > 0);
p(I) = p_mir(I)./(p_mir(I)+p_nonmir(I));
[scorei,pos_ind] = max(p);
posi = pos_list(pos_ind);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function p_loopdist = loopdist_prob(pos_list, model, endbulgesi);
% calculates the probability of each position in the list based on distance from loop

```

```

%uses gaussian probability distribution
seq_size = length(endbulgesi);
lb = find(endbulgesi);
eb_begin = lb(1);
eb_end = lb(end);
zloopdist = zeros(size(pos_list)); %standardized variables
side = sign(pos_list - eb_begin);
lup = find(side == -1);
zloopdist(lup) = (eb_begin - pos_list(lup) - model.pos_upper_mean_dist)/model.pos_upper_std_dist;
llw = find(side == 1);
zloopdist(llw) = (pos_list(llw)-eb_end - model.pos_lower_mean_dist)/model.pos_lower_std_dist;
p_loopdist = exp(-0.5*zloopdist.^2);
p_loopdist = p_loopdist/sum(p_loopdist);
return
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [p_nuc_mir,p_nuc_nonmir] = nuc_pos_prob(pos_list,model,seqsi);
p1_nuc_mir = model.pos_p1_nuc_mir;
p2_nuc_mir = model.pos_p2_nuc_mir;
p1_nuc_nonmir = model.pos_p1_nuc_nonmir;
p2_nuc_nonmir = model.pos_p2_nuc_nonmir;
win_len = model.win_len;
p_nuc_mir = zeros(size(pos_list));
p_nuc_nonmir = zeros(size(pos_list));
for i=1:length(pos_list)
    pos = pos_list(i);
    win_inds = pos:min([pos+win_len-1,length(seqsi)]);
    win_len_actual = length(win_inds);
    winseq = seqsi(win_inds);

    %multiply probabilities of single nucleotides in window 'win'
    if model.pos_nuc_order == 1
        %1 gram
        p_nuc_i = 1;
        for j = 1:win_len_actual
            p_nuc_i = p_nuc_i * p1_nuc_mir(j,winseq(j));
        end
    else
        %2 gram
        p_nuc_i = p1_nuc_mir(1,winseq(1));
        for j = 1:win_len_actual-1
            p_nuc_i = p_nuc_i * ...
                p2_nuc_mir(j,winseq(j),winseq(j+1))/p1_nuc_mir(j,winseq(j));
        end
    end
    %normalize by window length
    p_nuc_mir(i) = p_nuc_i^(win_len/win_len_actual);
    %calculate p(win given nonmir)
    if model.pos_nuc_order == 1
        p_nuc_i = 1;

```

```

for j = 1:win_len_actual
    p_nuc_i = p_nuc_i * p1_nuc_nonmir(winseq(j));
end
else
    p_nuc_i = p1_nuc_nonmir(1,winseq(1));
for j = 1:win_len_actual-1
    p_nuc_i = p_nuc_i * p2_nuc_nonmir(j,winseq(j),winseq(j+1))/p1_nuc_nonmir(j,winseq(j));
end
end
%normalize by window length
p_nuc_nonmir(i) = p_nuc_i^(win_len/win_len_actual);
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [p_bulge_mir,p_bulge_nonmir] = bulge_pos_prob(pos_list,model,bulges1i,bulges2i);
win_len = model.win_len;
if(model.pos_bulge == 1)
    pb_mir = model.pos_pb1_mir;
    pb_nonmir = model.pos_pb1_nonmir;
    bulges = bulges1i;
elseif(model.pos_bulge == 2)
    pb_mir = model.pos_pb2_mir;
    pb_nonmir = model.pos_pb2_nonmir;
    bulges = bulges2i;
elseif(model.pos_bulge == 0)
    pb_mir = model.pos_pbtot_mir;
    pb_nonmir = model.pos_pbtot_nonmir;
    bulges = bulges1i+bulges2i;
else
    error('model.pos_bulge must be 1 2 or 0');
end
p_bulge_mir = zeros(size(pos_list));
p_bulge_nonmir = zeros(size(pos_list));
for i=1:length(pos_list)
    pos = pos_list(i);
    win_inds = pos:min([pos+win_len-1,length(bulges)]);
    win_len_actual = length(win_inds);
    winbulges = bulges(win_inds);
    J0 = find(winbulges == 0);
    J1 = find(winbulges);
    p_bulge_i = prod(pb_mir(J1)) * prod(1-pb_mir(J0));
    p_bulge_mir(i) = p_bulge_i^(win_len/win_len_actual);
    p_bulge_i = prod(pb_nonmir(J1)) * prod(1-pb_nonmir(J0));
    p_bulge_nonmir(i) = p_bulge_i^(win_len/win_len_actual);
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [p_base_pair_mir,p_base_pair_nonmir] = base_pair_prob(pos_list,model,seqsi,ai);
win_len = model.win_len;
p_bp_mir = model.p_bp_mir;

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p_bp_nonmir = model.p_bp_nonmir;
seqbp = nuc2bp(seqsi,ai,model.pos_base_pair_states);
p_base_pair_mir = zeros(size(pos_list));
p_base_pair_nonmir = zeros(size(pos_list));
for i=1:length(pos_list)
    pos = pos_list(i);
    win_inds = pos:min([pos+win_len-1,length(seqsi)]);
    win_len_actual = length(win_inds);
    pmir_i = 1;
    pnonmir_i = 1;
    for j = 1:model.pos_base_pair_states
        pmir_i = pmir_i * p_bp_mir(j)^sum(seqbp(win_inds) == j);
        pnonmir_i = pnonmir_i * p_bp_nonmir(j)^sum(seqbp(win_inds) == j);
    end
    p_base_pair_mir(i) = pmir_i^(win_len/win_len_actual);
    p_base_pair_nonmir(i) = pnonmir_i^(win_len/win_len_actual);
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [win_pos,win_score] = bayes_predict_win(model,seqs,anti_inds,bulges1,bulges2,endbulges)
%[win_pos,score] = bayes_predict_win(model,seqs,anti_inds,bulges1,bulges2,endbulges)
% find the best window position by its matching to the bayesian model
mfes = anti_inds_to_mfe(anti_inds);
for i = 1:length(seqs)
    %disp(num2str(i));
    [win_posi, win_scorei] = bayes_predict_win_i(model,seqs{i},mfes{i},anti_inds{i},bulges1{i},bulges2{i},endbulges{i});
    win_pos(i) = win_posi;
    win_score(i) = win_scorei;
end
return
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [win_pos, win_score] = bayes_predict_win_i(model,seqsi,mfei,ai,bulges1i,bulges2i, endbulgesi);
p_loopdist = loopdist_bp_prob_normal(model,mfei);
[p_num_bps_mir,p_num_bps_nonmir] = num_bps_prob_hist(model,mfei,ai);
[p_win_sym_mir,p_win_sym_nonmir] = win_sym_prob(model,mfei,ai);
[p_pos_bulge_mir,p_pos_bulge_nonmir] = win_bulges_pos_prob(model,mfei,bulges1i,bulges2i,0);
[p_base_pair_mir,p_base_pair_nonmir] = win_base_pair_prob(model,mfei,ai,seqsi);
[p_nuc_mir,p_nuc_nonmir] = win_nuc_positional_prob_sw(model,seqsi,mfei);
p_mir = ones(1,size(mfei,1));
p_nonmir = ones(1,size(mfei,1));
if(model.win_use_loopdist)
    p_mir = p_mir.*p_loopdist;
    p_nonmir = p_nonmir.*(1-p_loopdist);
end
if(model.win_use_num_bps)
    p_mir = p_mir.*p_num_bps_mir;
    p_nonmir = p_nonmir.*p_num_bps_nonmir;
end
if(model.win_use_win_sym)

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    p_mir = p_mir.*p_win_sym_mir;
    p_nonmir = p_nonmir.*p_win_sym_nonmir;
end
if(model.win_use_pos_bulge)
    p_mir = p_mir.*p_pos_bulge_mir;
    p_nonmir = p_nonmir.*p_pos_bulge_nonmir;
end
if(model.win_use_base_pair)
    p_mir = p_mir.*p_base_pair_mir;
    p_nonmir = p_nonmir.*p_base_pair_nonmir;
end
if(model.win_use_nuc)
    p_mir = p_mir.*p_nuc_mir;
    p_nonmir = p_nonmir.*p_nuc_nonmir;
end
I = find((p_mir + p_nonmir) > 0);
p(I) = p_mir(I)./(p_mir(I)+p_nonmir(I));
[win_score,win_pos] = max(p);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function p_loopdist = loopdist_bp_prob_normal(model,mfe);
n_bps = size(mfe,1);
wp = 1:n_bps;
zloopdist = ((n_bps - wp) - model.mean_loopdist_bp)/model.std_loopdist_bp;
zloopdist(1:model.min_win_bp-1) = 0; % illegal windows.
p_loopdist = exp(-0.5*zloopdist.^2);
p_loopdist = p_loopdist/sum(p_loopdist);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [p_num_bps_mir,p_num_bps_nonmir] = num_bps_prob_hist(model,mfe,ai);
win_len = model.win_len;
n_bps = size(mfe,1);
p_num_bps_mir = zeros(1,n_bps);
p_num_bps_nonmir = zeros(1,n_bps);
is_paired = (ai~=0);
for wp = model.min_win_bp:n_bps
    pos3_on_arm5 = mfe(wp,1);
    pos5_on_arm3 = mfe(wp,2);
    pos5_on_arm5 = max(1,pos3_on_arm5-win_len+1);
    pos3_on_arm3 = min(length(ai),pos5_on_arm3+win_len-1);
    win5inds = pos5_on_arm5:pos3_on_arm5;
    win3inds = pos5_on_arm3:pos3_on_arm3;
    numpaired5 = sum(is_paired(win5inds));
    numpaired3 = sum(is_paired(win3inds));
    num_bps_i = min(numpaired5,numpaired3);
    % mir
    tt = find(model.win_num_bps_mir_vals == num_bps_i);
    if(tt)
        p_num_bps_mir_i = model.win_num_bps_mir_ps(tt);
    else

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```

    p_num_bps_mir_i = 0;
end
p_num_bps_mir_i = p_num_bps_mir_i*(win_len/mean(length(win5inds),length(win3inds)));
p_num_bps_mir(wp) = p_num_bps_mir_i;
% nonmir
tt = find(model.win_num_bps_nonmir_vals == num_bps_i);
if(tt)
    p_num_bps_nonmir_i = model.win_num_bps_nonmir_ps(tt);
else
    p_num_bps_nonmir_i = 0;
end
p_num_bps_nonmir_i = p_num_bps_nonmir_i*(win_len/mean(length(win5inds),length(win3inds)));
p_num_bps_nonmir(wp) = p_num_bps_nonmir_i;
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [p_win_sym_mir,p_win_sym_nonmir] = win_sym_prob(model,mfe,ai);
win_len = model.win_len;
n_bps = size(mfe,1);
p_win_sym_mir = zeros(1,n_bps);
p_win_sym_nonmir = zeros(1,n_bps);
is_paired = (ai~=0);
for wp = model.min_win_bp:n_bps
    pos3_on_arm5 = mfe(wp,1);
    pos5_on_arm3 = mfe(wp,2);
    pos5_on_arm5 = max(1,pos3_on_arm5-win_len+1);
    pos3_on_arm3 = min(length(ai),pos5_on_arm3+win_len-1);
    win5inds = pos5_on_arm5:pos3_on_arm5;
    win3inds = pos5_on_arm3:pos3_on_arm3;
    numunpaired5 = sum(~is_paired(win5inds));
    numunpaired3 = sum(~is_paired(win3inds));
    win_sym_i = abs(numunpaired5-numunpaired3);
    % mir
    tt = find(model.win_sym_mir_vals == win_sym_i);
    if(tt)
        p_win_sym_mir_i = model.win_sym_mir_ps(tt);
    else
        p_win_sym_mir_i = 0;
    end
    p_win_sym_mir_i = p_win_sym_mir_i*sqrt(win_len/mean(length(win5inds),length(win3inds)));
    p_win_sym_mir(wp) = p_win_sym_mir_i;
    % nonmir
    tt = find(model.win_sym_nonmir_vals == win_sym_i);
    if(tt)
        p_win_sym_nonmir_i = model.win_sym_nonmir_ps(tt);
    else
        p_win_sym_nonmir_i = 0;
    end
    p_win_sym_nonmir_i = p_win_sym_nonmir_i*sqrt(win_len/mean(length(win5inds),length(win3inds)));
    p_win_sym_nonmir(wp) = p_win_sym_nonmir_i;
end

```

```

end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [p_pos_bulge_mir,p_pos_bulge_nonmir] = win_bulges_pos_prob(model,mfe,bulges1i,bulges2i,use_avg);
bulge_flag = model.win_bulge;
win_len = model.win_len;
n_bps = size(mfe,1);
p_pos_bulge_mir = zeros(1,n_bps);
p_pos_bulge_nonmir = zeros(1,n_bps);
pb_arm5_mir = model.win_bulge_posit_arm5_mir;
pb_arm3_mir = model.win_bulge_posit_arm3_mir;
pb1_arm5_mir = model.win_bulge1_posit_arm5_mir;
pb1_arm3_mir = model.win_bulge1_posit_arm3_mir;
pb2_arm5_mir = model.win_bulge2_posit_arm5_mir;
pb2_arm3_mir = model.win_bulge2_posit_arm3_mir;
pb_arm5_nonmir = model.win_bulge_posit_arm5_nonmir;
pb_arm3_nonmir = model.win_bulge_posit_arm3_nonmir;
pb1_arm5_nonmir = model.win_bulge1_posit_arm5_nonmir;
pb1_arm3_nonmir = model.win_bulge1_posit_arm3_nonmir;
pb2_arm5_nonmir = model.win_bulge2_posit_arm5_nonmir;
pb2_arm3_nonmir = model.win_bulge2_posit_arm3_nonmir;
if(use_avg)
    pb_mir = 0.5*(pb_arm5_mir+pb_arm3_mir);
    pb_arm5_mir = pb_mir;
    pb_arm3_mir = pb_mir;
    pb1_mir = 0.5*(pb1_arm5_mir+pb1_arm3_mir);
    pb1_arm5_mir = pb1_mir;
    pb1_arm3_mir = pb1_mir;
    pb2_mir = 0.5*(pb2_arm5_mir+pb2_arm3_mir);
    pb2_arm5_mir = pb2_mir;
    pb2_arm3_mir = pb2_mir;
    pb_nonmir = 0.5*(pb_arm5_nonmir+pb_arm3_nonmir);
    pb_arm5_nonmir = pb_nonmir;
    pb_arm3_nonmir = pb_nonmir;
    pb1_nonmir = 0.5*(pb1_arm5_nonmir+pb1_arm3_nonmir);
    pb1_arm5_nonmir = pb1_nonmir;
    pb1_arm3_nonmir = pb1_nonmir;
    pb2_nonmir = 0.5*(pb2_arm5_nonmir+pb2_arm3_nonmir);
    pb2_arm5_nonmir = pb2_nonmir;
    pb2_arm3_nonmir = pb2_nonmir;
end
if(bulge_flag == 1)
    pb_arm5_mir = pb1_arm5_mir;
    pb_arm3_mir = pb1_arm3_mir;
    pb_arm5_nonmir = pb1_arm5_nonmir;
    pb_arm3_nonmir = pb1_arm3_nonmir;
    bulgesi = bulges1i;
elseif(bulge_flag == 2)
    pb_arm5_mir = pb2_arm5_mir;
    pb_arm3_mir = pb2_arm3_mir;

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pb_arm5_nonmir = pb2_arm5_nonmir;
pb_arm3_nonmir = pb2_arm3_nonmir;
bulgesi = bulges2i;
else
    % just use the total pb.
    bulgesi = bulges1i+bulges2i;
end
for wp = model.min_win_bp:n_bps
    pos3_on_arm5 = mfe(wp,1);
    pos5_on_arm3 = mfe(wp,2);
    pos5_on_arm5 = max(1,pos3_on_arm5-win_len+1);
    pos3_on_arm3 = min(length(bulgesi),pos5_on_arm3+win_len-1);
    win5 = bulgesi(pos3_on_arm5:-1:pos5_on_arm5); % always start from loop side
    win3 = bulgesi(pos5_on_arm3:pos3_on_arm3);
    win5_len_actual = length(win5);
    win3_len_actual = length(win3);

    J0 = find(win5 == 0);
    J1 = find(win5);
    p_bulges5_mir_i = prod(pb_arm5_mir(J1)) * prod(1-pb_arm5_mir(J0));
    p_bulges5_mir_i = p_bulges5_mir_i^(win_len/win5_len_actual);
    p_bulges5_nonmir_i = prod(pb_arm5_nonmir(J1)) * prod(1-pb_arm5_nonmir(J0));
    p_bulges5_nonmir_i = p_bulges5_nonmir_i^(win_len/win5_len_actual);
    J0 = find(win3 == 0);
    J1 = find(win3);
    p_bulges3_mir_i = prod(pb_arm3_mir(J1)) * prod(1-pb_arm3_mir(J0));
    p_bulges3_mir_i = p_bulges3_mir_i^(win_len/win3_len_actual);
    p_bulges3_nonmir_i = prod(pb_arm3_nonmir(J1)) * prod(1-pb_arm3_nonmir(J0));
    p_bulges3_nonmir_i = p_bulges3_nonmir_i^(win_len/win3_len_actual);

    p_pos_bulge_mir(wp) = sqrt(p_bulges5_mir_i*p_bulges3_mir_i);
    p_pos_bulge_nonmir(wp) = sqrt(p_bulges5_nonmir_i*p_bulges3_nonmir_i);
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [p_base_pair_mir,p_base_pair_nonmir] = win_base_pair_prob(model,mfe,ai,seq);
win_len = model.win_len;
base_pair_states = model.win_base_pair_states;
p_bp_arm5_mir = model.win_base_pair_arm5_mir;
p_bp_arm3_mir = model.win_base_pair_arm3_mir;
p_bp_arm5_nonmir = model.win_base_pair_arm5_nonmir;
p_bp_arm3_nonmir = model.win_base_pair_arm3_nonmir;
n_bps = size(mfe,1);
p_base_pair = zeros(1,n_bps);
t1{1} = seq;
t2{1} = ai;
t3 = nuc2bp(t1,t2,base_pair_states);
seqbp = t3{1};
for wp = model.min_win_bp:n_bps
    pos3_on_arm5 = mfe(wp,1);

```

```

pos5_on_arm3 = mfe(wp,2);
pos5_on_arm5 = max(1,pos3_on_arm5-win_len+1);
pos3_on_arm3 = min(length(ai),pos5_on_arm3+win_len-1);
win5inds = (pos5_on_arm5:pos3_on_arm5);
win3inds = (pos5_on_arm3:pos3_on_arm3);
% mir
p5_mir_i = 1;
p3_mir_i = 1;
for j = 1:base_pair_states
    p5_mir_i = p5_mir_i * p_bp_arm5_mir(j)^sum(seqbp(win5inds) == j);
    p3_mir_i = p3_mir_i * p_bp_arm3_mir(j)^sum(seqbp(win3inds) == j);
end
p5_mir_i = p5_mir_i.^(win_len/length(win5inds));
p3_mir_i = p3_mir_i.^(win_len/length(win3inds));
p_base_pair_mir(wp) = sqrt(p5_mir_i*p3_mir_i);
% nonmir
p5_nonmir_i = 1;
p3_nonmir_i = 1;
for j = 1:base_pair_states
    p5_nonmir_i = p5_nonmir_i * p_bp_arm5_nonmir(j)^sum(seqbp(win5inds) == j);
    p3_nonmir_i = p3_nonmir_i * p_bp_arm3_nonmir(j)^sum(seqbp(win3inds) == j);
end
p5_nonmir_i = p5_nonmir_i.^(win_len/length(win5inds));
p3_nonmir_i = p3_nonmir_i.^(win_len/length(win3inds));
p_base_pair_nonmir(wp) = sqrt(p5_nonmir_i*p3_nonmir_i);
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [p_nuc_mir,p_nuc_nonmir] = win_nuc_positional_prob_sw(model,seq,mfe);
% look at AT as one thing and at CG as one
% for now implemented only 1gram of this version
win_len = model.win_len;
win_len_common = min(win_len,model.win_nuc_pos_win);
p1_5_mir = model.win_nuc_pos_p1_5_mir;
p2_5_mir = model.win_nuc_pos_p2_5_mir;
p1_3_mir = model.win_nuc_pos_p1_3_mir;
p2_3_mir = model.win_nuc_pos_p2_3_mir;
p1_5_nonmir = model.win_nuc_pos_p1_5_nonmir;
p2_5_nonmir = model.win_nuc_pos_p2_5_nonmir;
p1_3_nonmir = model.win_nuc_pos_p1_3_nonmir;
p2_3_nonmir = model.win_nuc_pos_p2_3_nonmir;
p1_5_mir = transform_p1(p1_5_mir);
p1_3_mir = transform_p1(p1_3_mir);
p1_5_nonmir = transform_p1(p1_5_nonmir);
p1_3_nonmir = transform_p1(p1_3_nonmir);
p2_5_mir = transform_p2(p2_5_mir);
p2_3_mir = transform_p2(p2_3_mir);
p2_5_nonmir = transform_p2(p2_5_nonmir);
p2_3_nonmir = transform_p2(p2_3_nonmir);
n_bps = size(mfe,1);

```

```

for wp = model.min_win_bp:n_bps
    pos3_on_arm5 = mfe(wp,1);
    pos5_on_arm3 = mfe(wp,2);
    pos5_on_arm5 = max(1,pos3_on_arm5-win_len+1);
    pos3_on_arm3 = min(length(seq),pos5_on_arm3+win_len-1);
    win5inds = (pos5_on_arm5:pos3_on_arm5);
    win3inds = (pos5_on_arm3:pos3_on_arm3);

    seq5_sw = transform_to_sw(seq(win5inds));
    seq3_sw = transform_to_sw(seq(win3inds));

    win5_len_actual = min(model.win_nuc_pos_win,length(seq5_sw));
    win3_len_actual = min(model.win_nuc_pos_win,length(seq3_sw));

    % mir
    if model.win_nuc_order == 1
        %1 gram
        p5_i = 1;
        for j = 1:win5_len_actual
            p5_i = p5_i * p1_5_mir(j,seq5_sw(j));
        end
        p3_i = 1;
        for j = 1:win3_len_actual
            p3_i = p3_i * p1_3_mir(j,seq3_sw(j));
        end
    else
        %2 gram
        p5_i = p1_5_mir(1,seq5_sw(1));
        for j = 1:win5_len_actual-1
            p5_i = p5_i * p2_5_mir(j,seq5_sw(j),seq5_sw(j+1))/p1_5_mir(j,seq5_sw(j));
        end
        p3_i = p1_3_mir(1,seq3_sw(1));
        for j = 1:win3_len_actual-1
            p3_i = p3_i * p2_3_mir(j,seq3_sw(j),seq3_sw(j+1))/p1_3_mir(j,seq3_sw(j));
        end
    end
    p5_i = p5_i.^(win_len_common/win5_len_actual);
    p3_i = p3_i.^(win_len_common/win3_len_actual);
    p_nuc_mir(wp) = sqrt(p5_i*p3_i);

    % nonmir
    if model.win_nuc_order == 1
        %1 gram
        p5_i = 1;
        for j = 1:win5_len_actual
            p5_i = p5_i * p1_5_nonmir(j,seq5_sw(j));
        end
        p3_i = 1;
        for j = 1:win3_len_actual
            p3_i = p3_i * p1_3_nonmir(j,seq3_sw(j));
        end
    end

```

```

    end
else
    %2 gram
    p5_i = p1_5_nonmir(1,seq5_sw(1));
    for j = 1:win5_len_actual-1
        p5_i = p5_i * p2_5_nonmir(j,seq5_sw(j),seq5_sw(j+1))/p1_5_nonmir(j,seq5_sw(j));
    end
    p3_i = p1_3_nonmir(1,seq3_sw(1));
    for j = 1:win3_len_actual-1
        p3_i = p3_i * p2_3_nonmir(j,seq3_sw(j),seq3_sw(j+1))/p1_3_nonmir(j,seq3_sw(j));
    end
end
end
p5_i = p5_i.^(win_len_common/win5_len_actual);
p3_i = p3_i.^(win_len_common/win3_len_actual);
p_nuc_nonmir(wp) = sqrt(p5_i*p3_i);
end
function s = transform_to_sw(seq)
for i=1:length(seq)
    if(seq(i)==1 | seq(i)==3)
        s(i)=1;
    else
        s(i)=2;
    end
end
end
function p1 = transform_p1(p1_in)
p1_new(1,:) = mean([p1_in(:,1),p1_in(:,3)]');
p1_new(2,:) = mean([p1_in(:,2),p1_in(:,4)]');
p1 = p1_new';
function p2 = transform_p2(p2_in)
Ns = size(p2_in,2);
for j=1:size(p2_in,1)
    tt = reshape(p2_in(j,,:),Ns,Ns);
    ttt(:,1) = (mean([tt(:,1),tt(:,3)]'))';
    ttt(:,2) = (mean([tt(:,2),tt(:,4)]'))';
    tttt(1,:) = mean([ttt(1,:);ttt(3,:)]);
    tttt(2,:) = mean([ttt(2,:);ttt(4,:)]);
    p2_new(j,,:) = tttt;
end
end
p2 = p2_new;
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function positions = get_possible_positions(model,mfes,endbulges,win_pos)
% function positions = get_possible_positions(model,mfes,endbulges,win_pos)
% positions{i} a list of possible positions given the window position win_pos(i)
% for each arm gives pos5 of the window on that arm plus model.possible_pos_back
% positions back and model.possible_pos_fwd positions fwd.
% will also work with win_pos of length=1 and endbulges being a vector instead of a cell
win_len = model.win_len;
naway = model.possible_pos_away;
nto = model.possible_pos_to;

```

```

if(naway<0 | nto<0)
    error('model.possible_pos_away and model.possible_pos_to must be nonnegative')
end
if(length(win_pos)==1)
    tt{1} = endbulges;
    endbulges = tt;
    ttt{1} = mfes;
    mfes = ttt;
end
for i=1:length(win_pos)
    wp = win_pos(i);
    endbulgesi = endbulges{i};
    mfe = mfes{i};
    pos3_on_arm5 = mfe(wp,1);
    pos5_on_arm3 = mfe(wp,2);
    pos5_on_arm5 = max(1,pos3_on_arm5-win_len+1);

    t5 = [max(1,pos5_on_arm5-naway) : pos5_on_arm5+nto];
    t3 = [pos5_on_arm3-nto : min(length(endbulgesi),pos5_on_arm3+naway)];
    % remove indices sitting on end bulge
    lb = find(endbulgesi);
    positions{i} = setdiff([t5,t3],lb);
end
function win_mirpos = get_win_pos_v1(mfes,anti_inds,mirpos,mirlen)
% function win_mirpos = get_win_pos(mfes,anti_inds,mirpos,mirlen)
% returns win_mirpos in index of basepair (from legs not loop).
% i.e. mfe(win_mirpos,1) is the nuc pos on the 5 arm
% for mir on arm3 returns the closest bp from its mirpos towards the legs
% for mir on arm5 returns the closest bp from its END (mirpos+mirlen-1) towards the legs
% also towards the legs
for i=1:length(mirpos)
    pos5 = mirpos(i);
    pos3 = pos5+mirlen(i)-1;
    mfe = mfes{i};
    arm5 = mfe(:,1);
    arm3 = mfe(:,2);
    eb_start = arm5(end)+1;
    eb_end = arm3(end)-1;
    eb_len = eb_end-eb_start+1;
    side5 = (pos5<eb_start);
    ai = anti_inds{i};
    is_paired = (ai~=0);
    if(side5)
        k=0;
        while(~is_paired(pos3-k))
            k=k+1;
        end
        win_mirpos(i) = find(arm5==(pos3-k));
    else
        k=0;

```

```

while(~is_paired(pos5+k))
    k=k+1;
end
win_mirpos(i) = find(arm3==(pos5+k));
end
if isempty(win_mirpos(i))
    error('get_win_pos: fatal error. aborting.');
```

```

end
end
function strseq = int2nuc(intseq, ncase)
%strseq = int2nuc(intseq, ncase)
%convert a sequence of '1 2 3 4' into 'A C T G' or 'a c t g'
% ncase = uppercase | lowercase
if(isletter(intseq(1)))
    strseq = intseq;
    return;
end
if nargin == 1
    ncase = 'uppercase';
end
if strcmp(ncase,'uppercase')
    nucs = 'ACTG';
elseif strcmp(ncase,'lowercase')
    nucs = 'actg';
end
strseq = char(size(intseq));
for i = 1:length(intseq)
    strseq(i) = nucs(intseq(i));
end
return
function [yside, yprec2] = interpolate_prob_new(score, fitfile);
%[yside, yprec2] = interpolate_prob_new(score, fitfile);
% load the parameters for interpolation
load(fitfile);
%interpolate
yside = interp1(xs,ys,score,'linear');
yprec2 = interp1(xp2,yp2,score,'linear');
% extrapolate if necessary
if(min(xs)==xs(1)) % x is increasing
    yside(score<xs(1)) = ys(1);
    yprec2(score<xp2(1)) = yp2(1);
    yside(score>xs(end)) = ys(end);
    yprec2(score>xp2(end)) = yp2(end);
else % x is decreasing
    yside(score>xs(1)) = ys(1);
    yprec2(score>xp2(1)) = yp2(1);
    yside(score<xs(end)) = ys(end);
    yprec2(score<xp2(end)) = yp2(end);
end
returnfunction [mean_dist,std_dist] = loopdist_bp_model_normal(win_pos,mfes)

```

```

for i=1:length(win_pos)
    n_bps = size(mfes{i},1);
    loopdist(i) = n_bps - win_pos(i);
end
% cut off outliers
lp = prctile(loopdist,[2.5 97.5]);
l = find(loopdist >= lp(1) & loopdist <=lp(2));
mean_dist = mean(loopdist(l));
std_dist = std(loopdist(l));
%figure;hist(loopdist,[0:max(loopdist+1)]);title('loopdist training');function
[upper_mean_dist,upper_std_dist,lower_mean_dist,lower_std_dist] = loopdist_model(pos, endbulges)
for i = 1:length(endbulges)
    eb = find(endbulges{i});
    side(i) = sign(pos(i) - eb(1)) ;
    loopdist(i) = 0.5* ( (1-side(i))*(eb(1) - pos(i)) + ...
        (1+side(i))*(pos(i)-eb(length(eb)))));
end
%keyboard
%upper strand
l = find(side == -1);
% cut off outliers
lp = prctile(loopdist(l),[2.5 97.5]);
l = find(side == -1 & loopdist > lp(1) & loopdist <lp(2));
upper_mean_dist = mean(loopdist(l));
upper_std_dist = std(loopdist(l));
%lower strand
l = find(side == 1);
% cut off outliers
lp = prctile(loopdist(l),[2.5 97.5]);
l = find(side == 1 & loopdist > lp(1) & loopdist <lp(2));
lower_mean_dist = mean(loopdist(l));
lower_std_dist = std(loopdist(l));
return
if(~exist('maxd'))
    maxd = 4;
end
randomize=0;
filename =['C:\rosetta\data_baseline_29_7\clust_proto_' num2str(maxd) '_' set_name '.txt'];
clust_proto = load(filename);
if length(clust_proto) ~= length(palseq)
    error('clust_proto wrong size');
end
if exist('randomize')
    if randomize == 1
        error('should load training set with randomize = 0 option');
    end
end
end
if(~exist('param_file'))
    params_tests;
else

```

```

    eval(param_file);
end
model = model_params;
mfes = anti_inds_to_mfe(anti_inds);
% win_pos(i) is the position of the window corresponding to mir i
win_pos = get_win_pos_v1(mfes,anti_inds,mirpos,mirlen);
n_all = length(palseq);
examples = find(clust_proto==1);
length(examples)
for i=1:length(examples)
    i
    bs = examples(i);% test set
    bt = setdiff(examples, bs);% train set

    model =
    bayes_learn_win(palseq(bt),anti_inds(bt),bulges1(bt),bulges2(bt),endbulges(bt),mirpos(bt),mirlen(bt),model);
    model =
    bayes_learn_pos_given_win(palseq(bt),anti_inds(bt),bulges1(bt),bulges2(bt),endbulges(bt),mirpos(bt),mirlen(bt),model);

    [win_pos_estm,win_scorem] =
    bayes_predict_win(model,palseq(bs),anti_inds(bs),bulges1(bs),bulges2(bs),endbulges(bs));
    win_pos_est(bs) = win_pos_estm;
    win_score(bs) =win_scorem;

    % use estimated win_pos for prediction of pos!
    [pos_estm,pos_scorem]
    =bayes_predict_pos_given_win(palseq(bs),win_pos_est(bs),anti_inds(bs),bulges1(bs),bulges2(bs),endbulges(bs),model);
    pos_est(bs) = pos_estm;
    pos_score(bs) = pos_scorem;
end
%modelrandomize=1;
if randomize
    rand('state',randstate);
    %rand('state',sum(100*clock));
    disp('performing randomized permutation');
    l = randperm(length(palseq));
    bulges1 = bulges1(l);
    bulges2 = bulges2(l);
    anti_inds = anti_inds(l);
    endbulges = endbulges(l);
    pal_id = pal_id(l);
    energy = energy(l);
    palseq = palseq(l);
    mirseq = mirseq(l);
    mirlen = mirlen(l);
    mirpos = mirpos(l);
    mfes = mfes(l);
end

```

```

if(~exist('mfold'))
    mfold = 3;
end
eval(param_file);
model = model_params;
n_all = length(palseq);
bins = round(0:n_all/mfold:n_all);
bins_all = 1:n_all;
m = 1;
while m <= mfold
    disp(num2str(m));

    bs = [bins(m)+1: bins(m+1)];% test set
    bt = setdiff(bins_all , bs);% train set

    disp(' ');
    disp(['m = ' num2str(m)]);

    model =
    bayes_learn_win(palseq(bt),anti_inds(bt),bulges1(bt),bulges2(bt),endbulges(bt),mirpos(bt),mirlen(bt),model);
    model =
    bayes_learn_pos_given_win(palseq(bt),anti_inds(bt),bulges1(bt),bulges2(bt),endbulges(bt),mirpos(bt),mirlen(bt),model);

    [win_pos_estm,win_scorem] =
    bayes_predict_win(model,palseq(bs),anti_inds(bs),bulges1(bs),bulges2(bs),endbulges(bs));
    win_pos_est(bs) = win_pos_estm;
    win_score(bs) =win_scorem;

    % use estimated win_pos for prediction of pos!
    [pos_estm,pos_scorem]
    =bayes_predict_pos_given_win(palseq(bs),win_pos_est(bs),anti_inds(bs),bulges1(bs),bulges2(bs),endbulges(bs),model);
    pos_est(bs) = pos_estm;
    pos_score(bs) = pos_scorem;

    m = m+1;
end
%modelmaxd = 4;
randomize=0;
filename =['C:\rosetta\data_baseline_29_7\clust_proto_' num2str(maxd) '_' set_name '.txt'];
clust_proto = load(filename);
if length(clust_proto) ~= length(palseq)
    error('clust_proto wrong size');
end
if exist('randomize')
    if randomize == 1
        error('should load training set with randomize = 0 option');
    end
end
end

```

```

if(~exist('param_file'))
    params_tests;
else
    eval(param_file);
end
model = model_params;
n_all = length(palseq);
examples = find(clust_proto==1);
length(examples)
for i=1:length(examples)
    bs = examples(i);% test set
    bt = setdiff(examples, bs);% train set

    model =
bayes_learn_win(palseq(bt),anti_inds(bt),bulges1(bt),bulges2(bt),endbulges(bt),mirpos(bt),mirlen(bt),model);
    [win_pos_estm,win_scorem] =
bayes_predict_win(model,palseq(bs),anti_inds(bs),bulges1(bs),bulges2(bs),endbulges(bs));

    win_pos_est(bs) = win_pos_estm;
    win_score(bs) =win_scorem;
end
modelrandomize=1;
if randomize
    rand('state',sum(100*clock));
    disp('performing randomized permutation');
    l = randperm(length(palseq));
    bulges1 = bulges1(l);
    bulges2 = bulges2(l);
    anti_inds = anti_inds(l);
    endbulges = endbulges(l);
    pal_id = pal_id(l);
    energy = energy(l);
    palseq = palseq(l);
    mirseq = mirseq(l);
    mirlen = mirlen(l);
    mirpos = mirpos(l);
    mfes = mfes(l);
end
if(~exist('mfold'))
    mfold = 10;
end
if(~exist('param_file'))
    params_tests;
else
    eval(param_file);
end
model = model_params;
n_all = length(palseq);
bins = round(0:n_all/mfold:n_all);
bins_all = 1:n_all;

```

```

m = 1;
while m <= mfold
    disp(num2str(m));

    bs = [bins(m)+1: bins(m+1)];% test set
    bt = setdiff(bins_all , bs);% train set

    disp(' ');
    disp(['m = ' num2str(m)]);

    model =
    bayes_learn_win(palseq(bt),anti_inds(bt),bulges1(bt),bulges2(bt),endbulges(bt),mirpos(bt),mirlen(bt),model);
    [win_pos_estm,win_scorem] =
    bayes_predict_win(model,palseq(bs),anti_inds(bs),bulges1(bs),bulges2(bs),endbulges(bs));

    win_pos_est(bs) = win_pos_estm;
    win_score(bs) =win_scorem;

    m = m+1;
end
modelfunction seqsbp = nuc2bp(seqs,anti_inds,base_pair_basis)
%seqsbp = nuc2bp(seqs,anti_inds,base_pair_basis)
%transform to base pair representation
%for a 3 state model {AT,CG,TG} -> 1 2 3
%for a 6 state {AT,CG,TG,TA,GC,GT} -> 1 2 3 4 5 6
%also works if seqs is a vector and not a cell array, in which case returns a vector
if(~iscell(seqs))
    tt{1} = seqs;
    seqs = tt;
    tt{1} = anti_inds;
    anti_inds = tt;
    vecflag = 1;
else
    vecflag = 0;
end
map = zeros(4);
map(1,3) = 1; %AT
map(2,4) = 2; %CG
map(3,4) = 3; %TG
if base_pair_basis == 3
    map = map+map';
else
    map(3,1) = 4; %AT
    map(4,2) = 5; %CG
    map(4,3) = 6; %TG
end
seqsbp = cell(size(seqs));
for i = 1:length(seqs)
    seqsi = seqs{i};
    seqsbpi = zeros(size(seqsi));

```

```

anti_indsi = anti_indsi{i};

l = find(anti_indsi ~= 0);
for j = 1:length(l)
    ij = l(j);
    seqsbpi(ij) = map(seqsi(ij),seqsi(anti_indsi(ij)));
end
seqsbp{i} = seqsbpi;
end
if(vecflag)
    tt=seqsbp{1};
    seqsbp = tt;
end
return
function [intseq, fault_seq] = nuc2int4_new(strseq);
%[intseq, fault_seq] = nuc2int4_new(strseq)
%convert a sequence of 'A C T G' into a array of 1 2 3 4
intseq = zeros(size(strseq));
fault_seq = 0;
for i = 1:length(strseq)
    switch upper(strseq(i))
        case 'A' , intseq(i) = 1;
        case 'C' , intseq(i) = 2;
        case 'T' , intseq(i) = 3;
        case 'G' , intseq(i) = 4;
        otherwise , intseq = []; fault_seq = 1; break;
    end
end
function [p1,p2]= nucleotide_pos_model_list(model,seqs,positions);
% function [p1,p2]= nucleotide_pos_model_list(model,seqs,positions);
% learns a nucleotide positional model of a list of positions
% positions{i} is the list of positions on seqs{i}
% will work also if positions is a vector and not a cell
win_len = model.win_len;
numseqs = length(positions);
if(numseqs~=length(seqs))
    error('number of seqs differs from length(positions)');
end
% transform positions into cell if it is not so.
if(~iscell(positions))
    for i=1:numseqs
        tt{i} = positions(i);
    end
    positions = tt;
end
beta = 0.5;
Ns = 4; %number of states
c1 = zeros(win_len,Ns);
c2 = beta*ones(win_len-1,Ns,Ns);
p1 = c1;

```

```

p2 = c2;
for i = 1:numseqs
    seq = seqs{i};
    pos_list = positions{i};
    for k = 1:length(pos_list)
        posk = pos_list(k); %current windows anchor
        %1 gram
        for j = posk:min([posk+win_len-1 length(seq)])
            jind = j-posk+1;
            c1(jind,seq(j)) = c1(jind,seq(j)) + 1;
        end
        %2 gram
        for j = posk:min([posk+win_len-1 length(seq)]-1)
            jind = j-posk+1;
            c2(jind,seq(j), seq(j+1)) = c2(jind,seq(j), seq(j+1)) + 1;
        end
    end
end
for j = 1:win_len
    p1(j,:) = c1(j,:)/sum(c1(j,:));
end
for j = 1:win_len-1
    p2(j,:) = c2(j,:)/sum(c2(j,:));
end
function [num_bps_vals,num_bps_ps] = num_bps_model_hist_list(mfes,anti_inds,model,wps)
numseqs = length(wps);
if(numseqs~=length(mfes) | numseqs~=length(anti_inds))
    error('number of seqs differs from length(wps)');
end
% transform wps into cell if it is not so.
if(~iscell(wps))
    for i=1:numseqs
        tt{i} = wps(i);
    end
    wps = tt;
end
beta = 0.5;
win_len = model.win_len;
num_bps = [];
for i=1:numseqs
    wp_list = wps{i};
    mfe = mfes{i};
    ai = anti_inds{i};
    is_paired = (ai~=0);
    for k=1:length(wp_list)
        wp = wp_list(k);
        pos3_on_arm5 = mfe(wp,1);
        pos5_on_arm3 = mfe(wp,2);
        pos5_on_arm5 = max(1,pos3_on_arm5-win_len+1);
        pos3_on_arm3 = min(length(ai),pos5_on_arm3+win_len-1);
    end
end

```

```

    numpaired5 = sum(is_paired(pos5_on_arm5:pos3_on_arm5));
    numpaired3 = sum(is_paired(pos5_on_arm3:pos3_on_arm3));
    num_bps = [num_bps,min(numpaired5,numpaired3)];
end
end
num_bps_vals = 0:model.win_num_bins_num_bps-1;
n = hist(num_bps,num_bps_vals);
n = n+beta;
num_bps_ps = n/sum(n);
%figure;bar(num_bps_vals,num_bps_ps);title('numbps hist training');
% general params
model_params.win_len = 22; % in nts.
% win params
model_params.win_base_pair_states = 6; % this param is used only for win prediction.
model_params.min_win_bp = 14; % do not allow window to start in bp lower than this.
model_params.win_bulge = 0; % for win prediction. which bulges to look at. 1/2 - bulges1/2, else total
model_params.win_nuc_order = 2; % for positional nuc in win
model_params.win_nuc_pos_win = 15; % for nuc_positional how far in window to look. put win_len for all window.
model_params.win_num_bins_sym = model_params.win_len;
model_params.win_num_bins_num_bps = model_params.win_len;
model_params.win_use_loopdist = 1;
model_params.win_use_win_sym = 1;
model_params.win_use_pos_bulge = 1;
model_params.win_use_num_bps = 1;
model_params.win_use_base_pair = 1;
model_params.win_use_nuc = 1;
% for prediction of pos_given_win
% if the below 2 params are both 0 only looks at the pos5.
model_params.possible_pos_away = 0; % how many to go from 5pos in direction away from loop
    % when searching for positions.
    % note that 0 doesn't go back at all.model_params.
model_params.possible_pos_to = 0; % same but towards loop
model_params.pos_nuc_order = 2; % nuc order for positional nuc
model_params.win_len_for_pos_nuc = 3; % size of win to count nucs. if win_len then looks at whole window
model_params.pos_bulge = 0; % which bulges to look at 1,2 or 0 for the total.
model_params.pos_base_pair_states = 6;
model_params.pos_use_loopdist = 1;
model_params.pos_use_pos_nuc = 1;
model_params.pos_use_pos_bulge = 0;
model_params.pos_use_base_pair = 1;

% general params
model_params.win_len = 22; % in nts.
% win params
model_params.win_base_pair_states = 6; % this param is used only for win prediction.
model_params.min_win_bp = 14; % do not allow window to start in bp lower than this.
model_params.win_bulge = 0; % for win prediction. which bulges to look at. 1/2 - bulges1/2, else total
model_params.win_nuc_order = 2; % for positional nuc in win
model_params.win_nuc_pos_win = 15; % for nuc_positional how far in window to look. put win_len for all window.
model_params.win_num_bins_sym = model_params.win_len;

```

```

model_params.win_num_bins_num_bps = model_params.win_len;
model_params.win_use_loopdist = 1;
model_params.win_use_win_sym = 1;
model_params.win_use_pos_bulge = 1;
model_params.win_use_num_bps = 1;
model_params.win_use_base_pair = 1;
model_params.win_use_nuc = 1;
% for prediction of pos_given_win
% if the below 2 params are both 0 only looks at the pos5.
model_params.possible_pos_away = 0; % how many to go from 5pos in direction away from loop
    % when searching for positions.
    % note that 0 doesn't go back at all.model_params.
model_params.possible_pos_to = 0; % same but towards loop
model_params.pos_nuc_order = 2; % nuc order for positional nuc
model_params.win_len_for_pos_nuc = 3; % size of win to count nucs. if win_len then looks at whole window
model_params.pos_bulge = 0; % which bulges to look at 1,2 or 0 for the total.
model_params.pos_base_pair_states = 6;
model_params.pos_use_loopdist = 1;
model_params.pos_use_pos_nuc = 1;
model_params.pos_use_pos_bulge = 0;
model_params.pos_use_base_pair = 1;

```

```

function p_bp = pos_base_pair_model_list(model,seqs,anti_inds,positions)

```

```

%function p_bp = base_pair_model_list(model,seqs,anti_inds,positions)

```

```

%learns a nonpositional model of base pairs

```

```

% positions{i} is the list of positions on seqs{i}

```

```

% will work also if positions is a vector and not a cell

```

```

win_len = model.win_len;

```

```

numseqs = length(positions);

```

```

if(numseqs~=length(seqs) | numseqs~=length(anti_inds))

```

```

    error('number of seqs or anti_inds differs from length(positions)');

```

```

end

```

```

% transform positions into cell if it is not so.

```

```

if(~iscell(positions))

```

```

    for i=1:numseqs

```

```

        tt{i} = positions(i);

```

```

    end

```

```

    positions = tt;

```

```

end

```

```

seqsbp = nuc2bp(seqs,anti_inds,model.pos_base_pair_states);

```

```

c_bp = zeros(1,model.pos_base_pair_states);

```

```

for i = 1:numseqs

```

```

    seqbp = seqsbp{i};

```

```

    pos_list = positions{i};

```

```

    for k = 1:length(pos_list)

```

```

        posk = pos_list(k); %current windows anchor

```

```

        inds = posk:min([posk+win_len-1 length(seqbp)]);

```

```

        for j = 1:model.pos_base_pair_states

```

```

            c_bp(j) = c_bp(j)+sum(seqbp(inds) == j);

```

```

        end

```

```

    end
end
p_bp = c_bp/sum(c_bp);
function [pb1,pb2,pbtot] = pos_bulge_pos_model_list(model,bulges1,bulges2,positions);
% function [pb1,pb2,pbtot] = pos_bulge_pos_model_list(model,bulges1,bulges2,positions);
% learns a bulge positional model of a list of positions
% positions{i} is the list of positions on seqs{i}
% will work also if positions is a vector and not a cell
win_len = model.win_len;
numseqs = length(positions);
if(numseqs~=length(bulges1) | numseqs~=length(bulges2))
    error('number of bulges differs from length(positions)');
end
% transform positions into cell if it is not so.
if(~iscell(positions))
    for i=1:numseqs
        tt{i} = positions(i);
    end
    positions = tt;
end
for i = 1:numseqs
    b1 = bulges1{i};
    b2 = bulges2{i};
    btot{i} = b1+b2;
end
pb1 = bulge_positional(model,bulges1,positions);
pb2 = bulge_positional(model,bulges2,positions);
pbtot = bulge_positional(model,btot,positions);
function p = bulge_positional(model,bulges,positions)
win_len = model.win_len;
c = zeros(win_len,2);
p = zeros(win_len,1);
for i = 1:length(bulges)
    bulgesi = bulges{i};
    pos_list = positions{i};
    for k = 1:length(pos_list)
        posk = pos_list(k); %current windows anchor
        inds = posk:min([posk+win_len-1 length(bulgesi)]);
        for j=1:length(inds)
            this_ind = inds(j);
            c(j,1) = c(j,1) + bulgesi(this_ind);
            c(j,2) = c(j,2) + (1-bulgesi(this_ind));
        end
    end
end
end
for j = 1:win_len
    p(j) = c(j,1)/sum(c(j,:));
end
function [seqs,anti_inds,bulges_nonsym,bulges_sym,endbulges,pal_id,energy,all_pal_ids] =
read_structure_with_id_fid(fid,seqtot,minbp)

```

```

% function [seqs,anti_inds,bulges_nonsym,bulges_sym,endbulges,pal_id,energy,all_pal_ids] =
read_structure_with_id_fid(fid,seqtot,minbp)
% same as read_structure_withanti_fid but reads file that have before the 4 line zucker draw
% a line giving the pal_id and a line giving the energy.
% all_pal_ids is all ids read from file, whether faulty or not
% new feature: checks that draw is not messed up and if it is gives faulty seq.
% minbp is the minimal number of basepair required for a legal pal.
Mxplen = 250; % maximal length of palindrom
counter = 0;
seq_no = 0;
seqs = cell(0);
bulges_nonsym= cell(0);
bulges_sym= cell(0);
endbulges = cell(0);
pal_id = zeros(0);
energy = zeros(0);
while ~feof(fid) & seq_no < seqtot
    this_pal_id = str2double(fgetl(fid));
    this_energy = str2double(fgetl(fid));
    structure = char(4,250);
    i = 0;
    line = fgetl(fid);
    if isempty(line)
        line = 'emptyline';
        fault_seq_emptyline = 1;
    else
        fault_seq_emptyline = 0;
    end
    while(line(1)~= '|') % if emptyline this is always true so will go into loop
        i = i+1;
        structure(i,1:length(line)) = line;
        line = fgetl(fid);
        if isempty(line)
            line = 'emptyline';
            fault_seq_emptyline = 1;
        end
    end
end
if(i~=4)
    fault_seq_numlines = 1;
else
    fault_seq_numlines = 0;
end

fault_seq_struct = 1; % guilty until proven innocent
fault_seq_nuc = 1;
fault_seq_minbp = 1;
if(fault_seq_numlines == 0 & fault_seq_emptyline==0)
    [seqi, anti_indi, bulge1i, bulge2i, endbulgei,fault_seq_struct] = get_features(structure);
    if(fault_seq_struct==0)
        % this is the old bulge1 and bulge2, now need to correct that
    end
end

```

```

bulge_nonsymi=bulge1i;
bulge_symi=bulge2i;
for j = 1:length(seqi)
    if(bulge_nonsymi(j))
        if(bulge_symi(max(1,j-1))) % a neighbor has a bulgesym flag on
            bulge_symi(j) = 1;
            bulge_nonsymi(j) = 0;
        end
    end
end
for j = length(seqi):-1:1
    if(bulge_nonsymi(j))
        if(bulge_symi(min(j+1,length(seqi)))) % a neighbor has a bulgesym flag on
            bulge_symi(j) = 1;
            bulge_nonsymi(j) = 0;
        end
    end
end
[intseq, fault_seq_nuc] = nuc2int4_new(seqi);
this_mfe = anti_inds_to_mfe(anti_indi);
n_bps = size(this_mfe,1);
if(n_bps < minbp)
    fault_seq_minbp = 1;
else
    fault_seq_minbp = 0;
end
end
end

if (fault_seq_struct == 0 & fault_seq_nuc == 0 & fault_seq_numlines == 0 & ...
    fault_seq_emptyline == 0 & fault_seq_minbp == 0)
    seq_no = seq_no + 1;
    seqs{seq_no} = intseq;
    anti_inds{seq_no} = anti_indi;
    bulges_nonsym{seq_no} = bulge_nonsymi;
    bulges_sym{seq_no} = bulge_symi;
    endbulges{seq_no} = endbulgei;
    pal_id(seq_no) = this_pal_id;
    energy(seq_no) = this_energy;
    counter = counter + 1;
    all_pal_ids(counter) = this_pal_id;
else
    disp(['faulty seq on pal id ' num2str(this_pal_id)])
    if(fault_seq_emptyline)
        disp(['reason is that there was an empty line in zucker']);
    elseif(fault_seq_numlines)
        disp(['reason is that there were not 4 lines in the draw']);
    elseif(fault_seq_struct)
        disp(['reason is that draw was messed has nuc in pair and bulge at the same time']);
    elseif(fault_seq_nuc)

```

```

        disp(['reason is that there was an illegal letter in the seq']);
elseif(fault_seq_minbp)
    disp(['reason is that there were less basepairs then minbp']);
end
counter = counter + 1;
all_pal_ids(counter) = this_pal_id;
end
end
return
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [seq, anti_ind, bulge1, bulge2, endbulge, fault_seq] = get_features(structure)
% get sequence as well as bulge structure
fault_seq = 0;
%upper half (5' side)
bulge_row = 1; % the row of bulge letters
bulge_row_opposite = 4;
uphalf = structure(1:2,:);
[j,k] = find(isletter(uphalf));
max_col = max(k);
tmpmat = zeros(2,max_col);
count = 0;
for col =1: max_col
    fl = find(isletter(uphalf(:,col)));
    if (length(fl)>1);
        fault_seq = 1;
        seq=nan;anti_ind=nan;bulge1=nan;bulge2=nan;endbulge=nan;
        return;
    end;
    if ~isempty(fl)
        count = count + 1;
        seq(count) = uphalf(fl,col);
        bulge = (fl == bulge_row);
        if(bulge)
            tmpmat(1,col) = 0;
        else
            tmpmat(1,col) = count;
        end
        bulge1(count) = 0;
        bulge2(count) = 0;
        if bulge & isletter(structure(bulge_row_opposite,col))
            bulge2(count) = 1;
        elseif bulge & ~isletter(structure(bulge_row_opposite,col))
            bulge1(count) = 1;
        end
    end
end
end
% endbulge is coded on the upper half
% go backwards from 3' side to 5' side
endbulge = zeros(size(bulge1));

```

```

lwhalf = structure(3:4,:);
pos = length(bulge1);
while bulge1(pos) == 1
    endbulge(pos) = 1;
    bulge1(pos) = 0;
    pos = pos - 1;
end
%lower half
bulge_row = 2; % 4 th line on structure is 2 line on lower half
bulge_row_opposite = 1;
[j,k] = find(isletter(lwhalf));
max_col = max(k);
for col = max_col:-1:1
    fl = find(isletter(lwhalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        seq(count) = lwhalf(fl,col);
        bulge = (fl == bulge_row);
        if(bulge)
            tmpmat(2,col) = 0;
        else
            tmpmat(2,col) = count;
        end
        bulge1(count) = 0;
        bulge2(count) = 0;
        if bulge & isletter(structure(bulge_row_opposite,col))
            bulge2(count) = 1;
        elseif bulge & ~isletter(structure(bulge_row_opposite,col))
            bulge1(count) = 1;
        end
        endbulge(count) = 0;
    end
end
anti_ind = zeros(size(bulge1));
for col=1:max_col
    if(tmpmat(1,col))
        anti_ind(tmpmat(1,col)) = tmpmat(2,col);
        anti_ind(tmpmat(2,col)) = tmpmat(1,col);
    end
end
return
function run_2stage_2pred()
%infile = 'c:\rosetta\data_baseline_29_7\zucker_draw_h152_pipe.txt';
infile = 'C:\rosetta\criteria_for_paper\tests\Zucker_Draw_7pals.txt';
outfile = 'C:\rosetta\criteria_for_paper\tests\out_7pals.txt';
model_filename = 'model_hmdc440_sanger_09_09_03_params1.mat';
fit_filename_both = 'fitfile_mfold3_use_bothsides_hmdc440_sanger_09_09_03_params1.mat';
fit_filename_best = 'fitfile_mfold3_use_bestsides_hmdc440_sanger_09_09_03_params1.mat';
fidin = fopen(infile,'r');
fidout = fopen(outfile,'w');

```

```

seqstot = 1000; %number of sequences to classify each loop
load(model_filename);
while ~feof(fidin)
    disp('reading structure...');
    [palseq,anti_inds,bulges1,bulges2,endbulges,pal_id,energy,all_pal_ids] = ...
        read_struct_minbp(fidin,seqstot,model.min_win_bp);
    mfes = anti_inds_to_mfe(anti_inds);
    [win_pos_est,win_score] = bayes_predict_win(model,palseq,anti_inds,bulges1,bulges2,endbulges);
    score = win_score;
    % use estimated win_pos for prediction of pos!
    [pos_est,pos_score]
    =bayes_predict_pos_given_win(palseq,win_pos_est,anti_inds,bulges1,bulges2,endbulges,model);

    clear pos_est_arm5 pos_est_arm3 pos_est_first pos_est_second res
    for i=1:length(win_score)
        mfe = mfes{i};
        pos_est_arm5(i) = max(1,(mfe(win_pos_est(i),1) - model.win_len + 1));
        pos_est_arm3(i) = mfe(win_pos_est(i),2);
        if(pos_est(i)==pos_est_arm5(i))
            pos_est_first(i) = pos_est_arm5(i);
            pos_est_second(i) = pos_est_arm3(i);
        elseif(pos_est(i)==pos_est_arm3(i))
            pos_est_first(i) = pos_est_arm3(i);
            pos_est_second(i) = pos_est_arm5(i);
        else
            disp('something is wrong: pos_est must be either pos_est_arm5 or pos_est_arm3. giving nan!');
            pos_est_first(i) = nan;
            pos_est_second(i) = nan;
        end
    end
end

% infer probabilities
[yside, yprec2_both] = interpolate_prob_new(score, fit_filename_both);
[yside, yprec2_best] = interpolate_prob_new(score, fit_filename_best);

%write to file
%seq_id0 is added so as to sequential order of sequence numbers
res = [pal_id; pos_est_first; pos_est_second; score; yprec2_both;yprec2_best];
fprintf(fidout, '%d %d %d %g %g %g\r\n', res);
end
fclose(fidin);
fclose(fidout);
function [pal_id,pos_est_first,pos_est_second,score,yprec2_both,yprec2_best] =
run_2stage_2pred_giveout(palseq,anti_inds,bulges1,bulges2,endbulges,pal_id,energy)
model_filename = 'model_hmdc440_sanger_09_09_03_params1.mat';
fit_filename_both = 'fitfile_mfold3_use_bothsides_hmdc440_sanger_09_09_03_params1.mat';
fit_filename_best = 'fitfile_mfold3_use_bestside_hmdc440_sanger_09_09_03_params1.mat';
load(model_filename);
mfes = anti_inds_to_mfe(anti_inds);
[win_pos_est,win_score] = bayes_predict_win(model,palseq,anti_inds,bulges1,bulges2,endbulges);

```

```

score = win_score;
% use estimated win_pos for prediction of pos!
[pos_est,pos_score]
= bayes_predict_pos_given_win(palseq,win_pos_est,anti_inds,bulges1,bulges2,endbulges,model);
for i=1:length(win_score)
    mfe = mfes{i};
    pos_est_arm5(i) = max(1,(mfe(win_pos_est(i),1) - model.win_len + 1));
    pos_est_arm3(i) = mfe(win_pos_est(i),2);
    if(pos_est(i)==pos_est_arm5(i))
        pos_est_first(i) = pos_est_arm5(i);
        pos_est_second(i) = pos_est_arm3(i);
    elseif(pos_est(i)==pos_est_arm3(i))
        pos_est_first(i) = pos_est_arm3(i);
        pos_est_second(i) = pos_est_arm5(i);
    else
        disp('something is wrong: pos_est must be either pos_est_arm5 or pos_est_arm3. giving nan!');
        pos_est_first(i) = nan;
        pos_est_second(i) = nan;
    end
end
% infer probabilities
[yside, yprec2_both] = interpolate_prob_new(score, fit_filename_both);
[yside, yprec2_best] = interpolate_prob_new(score, fit_filename_best);
data_dir = 'data_baseline_29_7';
%set_name = 'h152';
%fid = fopen(['c:\rosetta\data_baseline_29_7\zucker_draw_' set_name '_pipe.txt'],'r');
set_name = 'hmdc440_sanger_09_09_03';
fid = fopen(['c:\rosetta\data_baseline_29_7\zucker_draw_' set_name '.txt'],'r');
[palseq,anti_inds,bulges1,bulges2,endbulges,pal_id,energy,all_pal_ids] = ...
    read_structure_with_id_fid(fid,1000);
fclose(fid);
if(length(pal_id)~=length(all_pal_ids))
    error('in human data do not allow faulty seqs, take out of there');
end
mfes = anti_inds_to_mfe(anti_inds);
fname = ['c:\rosetta\data_baseline_29_7\mirseq_' set_name '.txt'];
[mirseq,mirlen] = read_seq_with_id(fname);
mirpos = locate_dicer(mirseq,palseq);
extension = [set_name '_mfold3_params1'];
param_file='params1';
params1;
model = model_params;
model = bayes_learn_win(palseq,anti_inds,bulges1,bulges2,endbulges,mirpos,mirlen,model);
model = bayes_learn_pos_given_win(palseq,anti_inds,bulges1,bulges2,endbulges,mirpos,mirlen,model);
eval(['save model_' extension '.mat model']);
mfold = 3;
mfold_cv_random;
% chooses the correct side to only test win prediction and not side prediction
for i=1:length(mirpos)
    mfe = mfes{i};

```

```

pos_est_arm5(i) = max(1,(mfe(win_pos_est(i),1) - model.win_len + 1));
pos_est_arm3(i) = mfe(win_pos_est(i),2);
d5 = abs(pos_est_arm5(i)-mirpos(i));
d3 = abs(pos_est_arm3(i)-mirpos(i));
pos_error(i) = min(d5,d3);
if(d3<d5)
    pos_est_side_known(i) = pos_est_arm3(i);
else
    pos_est_side_known(i) = pos_est_arm5(i);
end
end
score=win_score;
figure
subplot(2,1,1)
res = analyse_errors_perc(pos_est,score,mirpos,endbulges);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
subplot(2,1,2)
if(~exist('num_bins'))
    num_bins = 6;
end
[xs,ys,xp2,yp2] = analyse_errors_bins2(pos_est,score,mirpos,endbulges,num_bins);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
eval(['print -djpeg use_bestside_' extension '.jpeg']);
eval(['save fitfile_use_bestside_' extension '.mat xs ys xp2 yp2']);
figure
subplot(2,1,1)
res = analyse_errors_perc(pos_est_side_known,score,mirpos,endbulges);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
subplot(2,1,2)
if(~exist('num_bins'))
    num_bins = 6;
end
[xs,ys,xp2,yp2] = analyse_errors_bins2(pos_est_side_known,score,mirpos,endbulges,num_bins);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
eval(['print -djpeg use_bothsides_' extension '.jpeg']);
eval(['save fitfile_use_bothsides_' extension '.mat xs ys xp2 yp2']);
figure;
fid = fopen(['info_and_criteria_' extension '.txt'],'w');
thresh_vec = [0:0.01:1];
clf:[thresh,acc2_bestside,captures] = analyse_errors_thresh_B(pos_est,score,mirpos,endbulges,thresh_vec);
clf:[thresh,acc2_bothsides,captures] =
analyse_errors_thresh_B(pos_est_side_known,score,mirpos,endbulges,thresh_vec);
grid
legend('off')
fprintf(fid,'%%%thresh\tacc2_bothsides\tacc2_bestside\tcaptures\r\n');
for i=1:length(thresh)

```

```

fprintf(fid,'%1.4f\t%1.4f\t%1.4f\t%d\r\n',thresh(i),acc2_bothsides(i),acc2_bestside(i),captures(i));
end
fclose(fid);
data_dir = 'data_baseline_29_7';
set_name = 'h152';
fid = fopen(['c:\rosetta\data_baseline_29_7\zucker_draw_' set_name '_pipe.txt'],'r');
%set_name = 'hmdc440_sanger_09_09_03';
%fid = fopen(['c:\rosetta\data_baseline_29_7\zucker_draw_' set_name '.txt'],'r');
[palseq,anti_inds,bulges1,bulges2,endbulges,pal_id,energy,all_pal_ids] = ...
    read_structure_with_id_fid(fid,1000);
fclose(fid);
if(length(pal_id)~=length(all_pal_ids))
    error('in human data do not allow faulty seqs, take out of there');
end
mfes = anti_inds_to_mfe(anti_inds);
fname = ['c:\rosetta\data_baseline_29_7\mirseq_' set_name '.txt'];
[mirseq,mirlen] = read_seq_with_id(fname);
mirpos = locate_dicer(mirseq,palseq);
extension = [set_name '_proto4_params1'];
params1;
model = model_params;
model = bayes_learn_win(palseq,anti_inds,bulges1,bulges2,endbulges,mirpos,mirlen,model);
model = bayes_learn_pos_given_win(palseq,anti_inds,bulges1,bulges2,endbulges,mirpos,mirlen,model);
eval(['save model_' extension '.mat model']);
mfold = 3;
maxd=4;
mfold_cv_proto;
mfes_e = mfes(examples);
mirpos_e = mirpos(examples);
win_score_e = win_score(examples);
pos_est_e = pos_est(examples);
win_pos_est_e = win_pos_est(examples);
endbulges_e = endbulges(examples);
% chooses the correct side to only test win prediction and not side prediction
for i=1:length(examples)
    mfe = mfes_e{i};
    pos_est_arm5(i) = max(1,(mfe(win_pos_est_e(i),1) - model.win_len + 1));
    pos_est_arm3(i) = mfe(win_pos_est_e(i),2);
    d5 = abs(pos_est_arm5(i)-mirpos_e(i));
    d3 = abs(pos_est_arm3(i)-mirpos_e(i));
    pos_error(i) = min(d5,d3);
    if(d3<d5)
        pos_est_side_known_e(i) = pos_est_arm3(i);
    else
        pos_est_side_known_e(i) = pos_est_arm5(i);
    end
end
score_e=win_score_e;
figure
subplot(2,1,1)

```

```

res = analyse_errors_perc(pos_est_e,score_e,mirpos_e,endbulges_e);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
subplot(2,1,2)
if(~exist('num_bins'))
    num_bins = 6;
end
[xs,ys,xp2,yp2] = analyse_errors_bins2(pos_est_e,score_e,mirpos_e,endbulges_e,num_bins);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
eval(['print -djpeg use_bestsides_' extension '.jpeg']);
eval(['save fitfile_use_bestsides_' extension '.mat xs ys xp2 yp2']);
figure
subplot(2,1,1)
res = analyse_errors_perc(pos_est_side_known_e,score_e,mirpos_e,endbulges_e);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
subplot(2,1,2)
if(~exist('num_bins'))
    num_bins = 6;
end
[xs,ys,xp2,yp2] = analyse_errors_bins2(pos_est_side_known_e,score_e,mirpos_e,endbulges_e,num_bins);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
eval(['print -djpeg use_bothsides_' extension '.jpeg']);
eval(['save fitfile_use_bothsides_' extension '.mat xs ys xp2 yp2']);
figure;
fid = fopen(['info_and_criteria_' extension '.txt'],'w');
thresh_vec = [0:0.01:1];
clf:[thresh,acc2_bestsides,captures] =
analyse_errors_thresh_B(pos_est_e,score_e,mirpos_e,endbulges_e,thresh_vec);
clf:[thresh,acc2_bothsides,captures] =
analyse_errors_thresh_B(pos_est_side_known_e,score_e,mirpos_e,endbulges_e,thresh_vec);
grid
legend('off')
fprintf(fid,'%%%thresh\tacc2_bothsides\tacc2_bestsides\tcaptures\r\n');
for i=1:length(thresh)
    fprintf(fid,'%1.4ft%1.4ft%1.4ft%1.4ft\r\n',thresh(i),acc2_bothsides(i),acc2_bestsides(i),captures(i));
end
fclose(fid);
function [p_bp_arm5,p_bp_arm3] = win_base_pair_model_list(mfes,anti_inds,seqs,model,wps)
numseqs = length(wps);
if(numseqs~=length(mfes) | numseqs~=length(anti_inds) | numseqs~=length(seqs))
    error('number of seqs differs from length(wps)');
end
% transform wps into cell if it is not so.
if(~iscell(wps))
    for i=1:numseqs
        tt{i} = wps(i);
    end
end

```

```

    wps = tt;
end
win_len = model.win_len;
base_pair_states = model.win_base_pair_states;
c_bp_arm5 = zeros(1,base_pair_states);
c_bp_arm3 = zeros(1,base_pair_states);
seqsbp = nuc2bp(seqs,anti_inds,base_pair_states);
for i = 1:numseqs
    wp_list = wps{i};
    mfe = mfes{i};
    ai = anti_inds{i};
    is_paired = (ai~=0);
    for k=1:length(wp_list)
        wp = wp_list(k);
        pos3_on_arm5 = mfe(wp,1);
        pos5_on_arm3 = mfe(wp,2);
        pos5_on_arm5 = max(1,pos3_on_arm5-win_len+1);
        pos3_on_arm3 = min(length(ai),pos5_on_arm3+win_len-1);
        for j = 1:base_pair_states
            c_bp_arm5(j) = c_bp_arm5(j)+sum(seqsbp{i}(pos5_on_arm5:pos3_on_arm5) == j);
            c_bp_arm3(j) = c_bp_arm3(j)+sum(seqsbp{i}(pos5_on_arm3:pos3_on_arm3) == j);
        end
    end
end
p_bp_arm5 = c_bp_arm5/sum(c_bp_arm5);
p_bp_arm3 = c_bp_arm3/sum(c_bp_arm3);
function [pb_arm5,pb_arm3,pb1_arm5,pb1_arm3,pb2_arm5,pb2_arm3] = ...
    win_bulge_pos_model_list(mfes,bulges1,bulges2,model,wps)
% on both sides of window from loop end of window
% pb1 - for bulges1 pb2 - for bulges2 pb - for total
win_len = model.win_len;
numseqs = length(wps);
if(numseqs~=length(mfes) | numseqs~=length(bulges1) | numseqs~=length(bulges2))
    error('number of seqs differs from length(wps)');
end
% transform wps into cell if it is not so.
if(~iscell(wps))
    for i=1:numseqs
        tt{i} = wps(i);
    end
    wps = tt;
end
for i=1:numseqs
    wp_list = wps{i};
    mfe = mfes{i};
    bulges{i} = bulges1{i}+bulges2{i};
    inds5_i = cell(0);
    inds3_i = cell(0);
    for k=1:length(wp_list)
        wp = wp_list(k);

```

```

pos3_on_arm5 = mfe(wp,1);
pos5_on_arm3 = mfe(wp,2);
pos5_on_arm5 = max(1,pos3_on_arm5-win_len+1);
pos3_on_arm3 = min(length(bulges{i}),pos5_on_arm3+win_len-1);
inds5_i{k} = pos3_on_arm5:-1:pos5_on_arm5; % always start from loop side
inds3_i{k} = pos5_on_arm3:pos3_on_arm3;
end
inds5{i} = inds5_i;
inds3{i} = inds3_i;
end
pb_arm5 = bulge_positional_list(model,bulges,inds5);
pb_arm3 = bulge_positional_list(model,bulges,inds3);
pb1_arm5 = bulge_positional_list(model,bulges1,inds5);
pb1_arm3 = bulge_positional_list(model,bulges1,inds3);
pb2_arm5 = bulge_positional_list(model,bulges2,inds5);
pb2_arm3 = bulge_positional_list(model,bulges2,inds3);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function p = bulge_positional_list(model,bulges,inds)
win_len = model.win_len;
c = zeros(win_len,2);
p = zeros(win_len,1);
for i = 1:length(bulges)
    bulgesi = bulges{i};
    for k = 1:length(inds{i})
        this_inds = inds{i}{k};
        for j=1:length(this_inds)
            this_ind = this_inds(j);
            c(j,1) = c(j,1) + bulgesi(this_ind);
            c(j,2) = c(j,2) + (1-bulgesi(this_ind));
        end
    end
end
end
for j = 1:win_len
    p(j) = c(j,1)/sum(c(j,:));
end
function [p1_5,p2_5,p1_3,p2_3] = win_nuc_positional_model_list(seqs,mfes,model,wps)
win_len = model.win_len;
numseqs = length(wps);
if(numseqs~=length(mfes) | numseqs~=length(seqs))
    error('number of seqs differs from length(wps)');
end
% transform wps into cell if it is not so.
if(~iscell(wps))
    for i=1:numseqs
        tt{i} = wps(i);
    end
    wps = tt;
end
beta = 0.5;

```

```

Ns = 4; %number of states
c1_5 = zeros(win_len,Ns);
c2_5 = beta*ones(win_len-1,Ns,Ns);
c1_3 = zeros(win_len,Ns);
c2_3 = beta*ones(win_len-1,Ns,Ns);
for i = 1:numseqs
    wp_list = wps{i};
    mfe = mfes{i};
    seqsi = seqs{i};
    for k=1:length(wp_list)
        wp = wp_list(k);
        pos3_on_arm5 = mfe(wp,1);
        pos5_on_arm3 = mfe(wp,2);
        pos5_on_arm5 = max(1,pos3_on_arm5-win_len+1);
        pos3_on_arm3 = min(length(seqsi),pos5_on_arm3+win_len-1);
        inds5 = pos5_on_arm5:pos3_on_arm5;
        inds3 = pos5_on_arm3:pos3_on_arm3;
        seq5 = seqsi(inds5);
        seq3 = seqsi(inds3);

        %1 gram
        for j = 1:length(seq5)
            c1_5(j,seq5(j)) = c1_5(j,seq5(j)) + 1;
        end
        %2 gram
        for j = 1:length(seq5)-1
            c2_5(j,seq5(j),seq5(j+1)) = c2_5(j,seq5(j), seq5(j+1)) + 1;
        end

        %1 gram
        for j = 1:length(seq3)
            c1_3(j,seq3(j)) = c1_3(j,seq3(j)) + 1;
        end
        %2 gram
        for j = 1:length(seq3)-1
            c2_3(j,seq3(j),seq3(j+1)) = c2_3(j,seq3(j), seq3(j+1)) + 1;
        end
    end
end
for j = 1:win_len
    p1_5(j,:) = c1_5(j,:)/sum(c1_5(j,:));
    p1_3(j,:) = c1_3(j,:)/sum(c1_3(j,:));
end
for j = 1:win_len-1
    p2_5(j,:) = c2_5(j,:)/sum(c2_5(j,:));
    p2_3(j,:) = c2_3(j,:)/sum(c2_3(j,:));
end
function [win_sym_vals,win_sym_ps] = win_sym_model_list(mfes,anti_inds,model,wps)
numseqs = length(wps);
if(numseqs~=length(mfes) | numseqs~=length(anti_inds))

```

```

    error('number of seqs differs from length(wps)');
end
% transform wps into cell if it is not so.
if(~iscell(wps))
    for i=1:numseqs
        tt{i} = wps(i);
    end
    wps = tt;
end
beta = 0.5;
win_len = model.win_len;
win_sym = [];
for i=1:numseqs
    wp_list = wps{i};
    mfe = mfes{i};
    ai = anti_inds{i};
    is_paired = (ai~=0);
    for k=1:length(wp_list)
        wp = wp_list(k);
        pos3_on_arm5 = mfe(wp,1);
        pos5_on_arm3 = mfe(wp,2);
        pos5_on_arm5 = max(1,pos3_on_arm5-win_len+1);
        pos3_on_arm3 = min(length(ai),pos5_on_arm3+win_len-1);
        numunpaired5 = sum(~is_paired(pos5_on_arm5:pos3_on_arm5));
        numunpaired3 = sum(~is_paired(pos5_on_arm3:pos3_on_arm3));
        win_sym = [win_sym,abs(numunpaired5-numunpaired3)];
    end
end
win_sym_vals = 0:model.win_num_bins_sym-1;
n = hist(win_sym,win_sym_vals);
n = n+beta;
win_sym_ps = n/sum(n);
%figure;bar(win_sym_vals,win_sym_ps);title('win sym training');

```

```

function [xs,ys,xp2,yp2] = analyse_errors_bins2(pos_estimated,score,pos, endbulges,N)
% measure the distribution of erros
if length(pos_estimated) ~= length(score)
    error('pos_estimated and score not compatible');
end
if length(pos_estimated) ~= length(pos)
    error('pos_estimated and pos not compatible');
end
if length(pos_estimated) ~= length(endbulges)
    error('pos_estimated and endbulges size not compatible');
end
if nargin == 4
    N = 6;
end
perc = [1:-1/N:0]*100;
thresh = prctile(score, perc);
accuracy = zeros(0);
correct_side_dist1 = zeros(0); %correct size, distance = 1;
correct_side_dist2 = zeros(0);
correct_side_disth = zeros(0);
wrong_side = zeros(0);
fraction = zeros(0);
count = 0;
N = length(pos);
for i = 1:length(endbulges)
    eb = find(endbulges{i});
    correct_side(i) = 0.5*( 1 + sign((pos_estimated(i) - eb(1))*(pos(i) -eb(1)))); %one for correct side estimate
end
for i = 1:length(thresh)-1
    l = find(score <= thresh(i) & score >= thresh(i+1));
    if ~isempty(l)
        count = count + 1;
        midbin(count) = mean(score(l));
        accuracy(count) = sum(pos_estimated(l) == pos(l))/length(l);

        J1 = find(correct_side(l) & abs(pos(l)- pos_estimated(l)) == 1);
        correct_side_dist1(count) = length(J1)/length(l);
        J2 = find(correct_side(l) & abs(pos(l)- pos_estimated(l)) == 2);
        correct_side_dist2(count) = length(J2)/length(l);
        J3 = find(correct_side(l) & abs(pos(l)- pos_estimated(l)) == 3);
        correct_side_dist3(count) = length(J3)/length(l);
        Jh = find(correct_side(l) & abs(pos(l)- pos_estimated(l)) > 3);
        correct_side_disth(count) = length(Jh)/length(l);

        wrong_side(count) = sum(1-correct_side(l))/length(l);

        fraction(count) = length(l)/N;
    else
        count = count+1;
        midbin(count) = NaN;;
    end
end

```

```

    accuracy(count) = NaN;
    correct_side_dist1(count) = NaN;
    correct_side_dist2(count) = NaN;
    correct_side_dsth(count) = NaN;
    wrong_side(count) = NaN;
    fraction(count) = NaN;
end
end
acc1 = accuracy + correct_side_dist1;
acc2 = accuracy + correct_side_dist1 + correct_side_dist2;
acc3 = accuracy + correct_side_dist1 + correct_side_dist2 + correct_side_dist3;
hold on
plot(midbin, acc3,'y','linewidth',2)
plot(midbin, acc2,'g','linewidth',2)
plot(midbin, acc1,'r','linewidth',2)
plot(midbin, accuracy,'b','linewidth',2)
plot(midbin, wrong_side,'k','linewidth',2)
plot(midbin,fraction,'c','linewidth',2)
legend('dist \leq 3', 'dist \leq 2', 'dist \leq 1', 'precise', 'wrong side',2);
plot(midbin, acc3,'dy')
plot(midbin, acc2,'*g')
plot(midbin, acc1,'or')
plot(midbin, accuracy,'bd')
plot(midbin, wrong_side,'kv')
xlabel('bin');
%axis([min(midbin)-1 max(midbin)+1 0 1])
[ry,yp2,mass,xp2,newy,pos] = isotonic_regression(midbin,acc2);
[ry,ys,mass,xs,newy,pos] = isotonic_regression(midbin,1-wrong_side);
returnfunction [x,ys,yp2,yp1,yp0] = analyse_errors_bins3(pos_estimated,score,pos, endbulges,N)
% measure the distribution of erros
if length(pos_estimated) ~= length(score)
    error('pos_estimated and score not compatible');
end
if length(pos_estimated) ~= length(pos)
    error('pos_estimated and pos not compatible');
end
if length(pos_estimated) ~= length(endbulges)
    error('pos_estimated and endbulges size not compatible');
end
if nargin == 4
    N = 6;
end
perc = [1:-1/N:0]*100;
thresh = prctile(score, perc);
accuracy = zeros(0);
correct_side_dist1 = zeros(0); %correct size, distance = 1;
correct_side_dist2 = zeros(0);
correct_side_dsth = zeros(0);
wrong_side = zeros(0);
fraction = zeros(0);

```

```

count = 0;
N = length(pos);
for i = 1:length(endbulges)
    eb = find(endbulges{i});
    correct_side(i) = 0.5*( 1 + sign((pos_estimated(i) - eb(1))*(pos(i) - eb(1)))); %one for correct side estimate
end
for i = 1:length(thresh)-1
    I = find(score <= thresh(i) & score >= thresh(i+1));
    if ~isempty(I)
        count = count + 1;
        midbin(count) = mean(score(I));
        accuracy(count) = sum(pos_estimated(I) == pos(I))/length(I);

        J1 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 1);
        correct_side_dist1(count) = length(J1)/length(I);
        J2 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 2);
        correct_side_dist2(count) = length(J2)/length(I);
        J3 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 3);
        correct_side_dist3(count) = length(J3)/length(I);
        Jh = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) > 3);
        correct_side_dsth(count) = length(Jh)/length(I);

        wrong_side(count) = sum(1-correct_side(I))/length(I);

        fraction(count) = length(I)/N;
    else
        count = count+1;
        midbin(count) = NaN;;
        accuracy(count) = NaN;
        correct_side_dist1(count) = NaN;
        correct_side_dist2(count) = NaN;
        correct_side_dsth(count) = NaN;
        wrong_side(count) = NaN;
        fraction(count) = NaN;
    end
end
acc1 = accuracy + correct_side_dist1;
acc2 = accuracy + correct_side_dist1 + correct_side_dist2;
acc3 = accuracy + correct_side_dist1 + correct_side_dist2 + correct_side_dist3;
hold on
plot(midbin, acc3,'y','linewidth',2)
plot(midbin, acc2,'g','linewidth',2)
plot(midbin, acc1,'r','linewidth',2)
plot(midbin, accuracy,'b','linewidth',2)
plot(midbin, wrong_side,'k','linewidth',2)
plot(midbin,fraction,'c','linewidth',2)
legend('dist \leq 3', 'dist \leq 2', 'dist \leq 1', 'precise', 'wrong side',2);
plot(midbin, acc3,'dy')
plot(midbin, acc2,'*g')
plot(midbin, acc1,'or')

```

```

plot(midbin, accuracy,'bd')
plot(midbin, wrong_side,'kv')
xlabel('bin');
%axis([min(midbin)-1 max(midbin)+1 0 1])
[ry,yp2,mass,xp2,newy,pos] = isotonic_regression(midbin,acc2);
[ry,yp1,mass,xp1,newy,pos] = isotonic_regression(midbin,acc1);
[ry,yp0,mass,xp0,newy,pos] = isotonic_regression(midbin,accuracy);
[ry,ys,mass,xs,newy,pos] = isotonic_regression(midbin,1-wrong_side);
x=xs;
returnfunction res = analyse_errors_perc(pos_estimated,score,pos, endbulges)
%analyse_errors_perc(pos_estimated,score,pos, endbulges)
% measure the distribution of erros
N = 100;
perc = [1:-1/N:0]*100;
thresh = prctile(score, perc);
accuracy = zeros(0);
correct_side_dist1 = zeros(0); %correct size, distance = 1;
correct_side_dist2 = zeros(0);
correct_side_dsth = zeros(0);
wrong_side = zeros(0);
fraction = zeros(0);
count = 0;
N = length(pos);
for i = 1:length(endbulges)
    eb = find(endbulges{i});
    correct_side(i) = 0.5*( 1 + sign((pos_estimated(i) - eb(1))*(pos(i) -eb(1))))); %one for correct side estimate
end
for i = 1:length(thresh)
    I = find(score >= thresh(i));
    if ~isempty(I)
        count = count + 1;
        accuracy(count) = sum(pos_estimated(I) == pos(I))/length(I);

        J1 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 1);
        correct_side_dist1(count) = length(J1)/length(I);
        J2 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 2);
        correct_side_dist2(count) = length(J2)/length(I);
        J3 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 3);
        correct_side_dist3(count) = length(J3)/length(I);
        Jh = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) > 3);
        correct_side_dsth(count) = length(Jh)/length(I);

        wrong_side(count) = sum(1-correct_side(I))/length(I);

        fraction(count) = length(I)/N;
    else
        count = count+1;
        accuracy(count) = NaN;
        correct_side_dist1(count) = NaN;
        correct_side_dist2(count) = NaN;
    end
end

```

```

    correct_side_dsth(count) = NaN;
    wrong_side(count) = NaN;
    fraction(count) = NaN;
end
end

acc1 = accuracy + correct_side_dist1;
acc2 = accuracy + correct_side_dist1 + correct_side_dist2;
acc3 = accuracy + correct_side_dist1 + correct_side_dist2 + correct_side_dist3;
%clf
hold on

plot(perc, acc3,'y','linewidth',2)
plot(perc, acc2,'g','linewidth',2)
plot(perc, acc1,'r','linewidth',2)
plot(perc, accuracy,'b','linewidth',2)
plot(perc, wrong_side,'k','linewidth',2)
plot(perc, thresh,'c','linewidth',2)
legend('dist \leq 3','dist \leq 2', 'dist \leq 1', 'precise', 'wrong side', 'threshold',2);
xlabel('percentage');
axis([0 100 0 1]);

%keyboard
%prepare result
N = length(accuracy);
res = [accuracy(N), acc1(N), acc2(N), acc3(N), 1-wrong_side(N), acc2(round(0.2*N))];
returnfunction analyse_errors_perc_2preds(pos_estimated,score,pos, endbulges,decide_by,pred_side)
%analyse_errors_perc(pos_estimated,score,pos, endbulges)
%pos_est and score are 2 cols (a pred for each arm with its score)
if(~exist('decide_by'))
    decide_by = 0;
end
if(decide_by == 1) % decide on prediction using real mirside
    for i=1:length(pos)
        lb = find(endbulges{i});
        eb_begin = lb(1);
        eb_end = lb(end);
        mirside = (pos(i)<eb_begin); % mirside=1 if mir is on arm5, 0 if on arm3.
        if(mirside) % arm5
            pos_est_arm(i) = pos_estimated(i,1);
            score_arm(i) = score(i,1);
        else
            pos_est_arm(i) = pos_estimated(i,2);
            score_arm(i) = score(i,2);
        end
    end
end
elseif(decide_by == 0) % decide by best score
    for i=1:length(pos)
        if(score(i,1)>score(i,2))
            pos_est_arm(i) = pos_estimated(i,1);

```

```

        score_arm(i) = score(i,1);
    else
        pos_est_arm(i) = pos_estimated(i,2);
        score_arm(i) = score(i,2);
    end
end
elseif(decide_by == 2) % decide by predicted side
    if(~exist('pred_side'))
        error('must give a predicted side for this option')
    end
    for i=1:length(pos)
        if(pred_side(i)==1) % arm5 predicted
            pos_est_arm(i) = pos_estimated(i,1);
            score_arm(i) = score(i,1);
        else
            pos_est_arm(i) = pos_estimated(i,2);
            score_arm(i) = score(i,2);
        end
    end
end
end
analyse_errors_perc(pos_est_arm,score_arm,pos,endbulges);
function res = analyse_errors_perc_noplot(pos_estimated,score,pos, endbulges)
%analyse_errors_perc(pos_estimated,score,pos, endbulges)
% measure the distribution of erros
N = 100;
perc = [1:-1/N:0]*100;
thresh = prctile(score, perc);
accuracy = zeros(0);
correct_side_dist1 = zeros(0); %correct size, distance = 1;
correct_side_dist2 = zeros(0);
correct_side_disth = zeros(0);
wrong_side = zeros(0);
fraction = zeros(0);
count = 0;
N = length(pos);
for i = 1:length(endbulges)
    eb = find(endbulges{i});
    correct_side(i) = 0.5*( 1 + sign((pos_estimated(i) - eb(1))*(pos(i) -eb(1))))); %one for correct side estimate
end
for i = 1:length(thresh)
    I = find(score >= thresh(i));
    if ~isempty(I)
        count = count + 1;
        accuracy(count) = sum(pos_estimated(I) == pos(I))/length(I);

        J1 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 1);
        correct_side_dist1(count) = length(J1)/length(I);
        J2 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 2);
        correct_side_dist2(count) = length(J2)/length(I);
        Jh = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) > 2);
    end
end

```

```

correct_side_dsth(count) = length(Jh)/length(I);

wrong_side(count) = sum(1-correct_side(I))/length(I);

fraction(count) = length(I)/N;
else
    count = count+1;
    accuracy(count) = NaN;
    correct_side_dist1(count) = NaN;
    correct_side_dist2(count) = NaN;
    correct_side_dsth(count) = NaN;
    wrong_side(count) = NaN;
    fraction(count) = NaN;
end
end

acc1 = accuracy + correct_side_dist1;
acc2 = accuracy + correct_side_dist1 + correct_side_dist2;
N = length(accuracy);
res = [accuracy(N), acc1(N), acc2(N), 1-wrong_side(N), acc2(round(0.2*N))];
returnfunction analyse_errors_thresh(pos_estimated,score,pos, endbulges,Np)
%analyse_errors_thresh(pos_estimated,score,pos, endbulges)
% measure the distribution of erros
if max(score) > 1
    mxscore = max(score);
else
    mxscore = 1;
end
if min(score) < 0
    mnscore = min(score);
else
    mnscore = 0;
end
if(~exist('Np'))
    Np = 500;
end
dth = (mxscore- mnscore)/Np;
thresh = mnscore:dth:mxscore;
accuracy = zeros(0);
correct_side_dist1 = zeros(0); %correct size, distance = 1;
correct_side_dist2 = zeros(0);
correct_side_dsth = zeros(0);
wrong_side = zeros(0);
fraction = zeros(0);
count = 0;
N = length(pos);
for i = 1:length(endbulges)
    eb = find(endbulges{i});
    correct_side(i) = 0.5*( 1 + sign((pos_estimated(i) - eb(1))*(pos(i) -eb(1))))); %one for correct side estimate

```

```

end
for i = 1:length(thresh)
    I = find(score >= thresh(i));
    if ~isempty(I)
        count = count + 1;
        accuracy(count) = sum(pos_estimated(I) == pos(I))/length(I);

        J1 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 1);
        correct_side_dist1(count) = length(J1)/length(I);
        J2 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 2);
        correct_side_dist2(count) = length(J2)/length(I);
        Jh = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) > 2);
        correct_side_dsth(count) = length(Jh)/length(I);

        wrong_side(count) = sum(1-correct_side(I))/length(I);

        fraction(count) = length(I)/N;
    else
        count = count+1;
        accuracy(count) = NaN;
        correct_side_dist1(count) = NaN;
        correct_side_dist2(count) = NaN;
        correct_side_dsth(count) = NaN;
        wrong_side(count) = NaN;
        fraction(count) = NaN;
    end
end

acc1 = accuracy + correct_side_dist1;
acc2 = accuracy + correct_side_dist1 + correct_side_dist2;
clf
hold on

plot(thresh, acc2,'g')
plot(thresh, acc1,'r')
plot(thresh, accuracy,'b')
plot(thresh, wrong_side,'k')
plot(thresh, fraction,'c')
legend('dist \leq 2', 'dist \leq 1', 'precise', 'wrong side', 'fraction');
xlabel('threshold');
%keyboard
returnfunction [thresh,acc2,captures] = analyse_errors_thresh_B(pos_estimated,score,pos, endbulges,thresh)
%analyse_errors_thresh_B(pos_estimated,score,pos, endbulges,thresh)
% receives the vector thresh
% measure the distribution of erros
if max(score) > 1
    mxscore = max(score);
else
    mxscore = 1;
end

```

```

end
if min(score) < 0
    mnscore = min(score);
else
    mnscore = 0;
end
accuracy = zeros(0);
correct_side_dist1 = zeros(0); %correct size, distance = 1;
correct_side_dist2 = zeros(0);
correct_side_dsth = zeros(0);
wrong_side = zeros(0);
fraction = zeros(0);
count = 0;
N = length(pos);
for i = 1:length(endbulges)
    eb = find(endbulges{i});
    correct_side(i) = 0.5*( 1 + sign((pos_estimated(i) - eb(1))*(pos(i) -eb(1))))); %one for correct side estimate
end
for i = 1:length(thresh)
    l = find(score >= thresh(i));
    captures(i) = length(l);
    if ~isempty(l)
        count = count + 1;
        accuracy(count) = sum(pos_estimated(l) == pos(l))/length(l);

        J1 = find(correct_side(l) & abs(pos(l)- pos_estimated(l)) == 1);
        correct_side_dist1(count) = length(J1)/length(l);
        J2 = find(correct_side(l) & abs(pos(l)- pos_estimated(l)) == 2);
        correct_side_dist2(count) = length(J2)/length(l);
        Jh = find(correct_side(l) & abs(pos(l)- pos_estimated(l)) > 2);
        correct_side_dsth(count) = length(Jh)/length(l);

        wrong_side(count) = sum(1-correct_side(l))/length(l);

        fraction(count) = length(l)/N;
    else
        count = count+1;
        accuracy(count) = NaN;
        correct_side_dist1(count) = NaN;
        correct_side_dist2(count) = NaN;
        correct_side_dsth(count) = NaN;
        wrong_side(count) = NaN;
        fraction(count) = NaN;
    end
end

acc1 = accuracy + correct_side_dist1;
acc2 = accuracy + correct_side_dist1 + correct_side_dist2;

```

```

hold on
plot(thresh, acc2,'g-o','linewidth',2)
plot(thresh, acc1,'r-o','linewidth',2)
plot(thresh, accuracy,'b-o','linewidth',2)
plot(thresh, wrong_side,'k-o','linewidth',2)
plot(thresh, fraction,'c-o','linewidth',2)
legend('dist \leq 2', 'dist \leq 1', 'precise', 'wrong side', 'fraction');
xlabel('threshold');
%keyboard
returnfunction [thresh,captures,acc2,acc1,accuracy,correctside] = ...
    analyse_errors_thresh_C(pos_estimated,score,pos, endbulges,thresh)
% [thresh,captures,acc2,acc1,accuracy,correctside] = analyse_errors_thresh_C(pos_estimated,score,pos,
endbulges,thresh)
% receives the vector thresh
% measure the distribution of erros
if max(score) > 1
    mxscore = max(score);
else
    mxscore = 1;
end
if min(score) < 0
    mnscore = min(score);
else
    mnscore = 0;
end
accuracy = zeros(0);
correct_side_dist1 = zeros(0); %correct size, distance = 1;
correct_side_dist2 = zeros(0);
correct_side_dsth = zeros(0);
wrong_side = zeros(0);
fraction = zeros(0);
count = 0;
N = length(pos);
for i = 1:length(endbulges)
    eb = find(endbulges{i});
    correct_side(i) = 0.5*( 1 + sign((pos_estimated(i) - eb(1))*(pos(i) -eb(1)))); %one for correct side estimate
end
for i = 1:length(thresh)
    I = find(score >= thresh(i));
    captures(i) = length(I);
    if ~isempty(I)
        count = count + 1;
        accuracy(count) = sum(pos_estimated(I) == pos(I))/length(I);

        J1 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 1);
        correct_side_dist1(count) = length(J1)/length(I);
        J2 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 2);
        correct_side_dist2(count) = length(J2)/length(I);
        Jh = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) > 2);
        correct_side_dsth(count) = length(Jh)/length(I);
    end
end

```

```

wrong_side(count) = sum(1-correct_side(l))/length(l);

fraction(count) = length(l)/N;
else
    count = count+1;
    accuracy(count) = NaN;
    correct_side_dist1(count) = NaN;
    correct_side_dist2(count) = NaN;
    correct_side_dsth(count) = NaN;
    wrong_side(count) = NaN;
    fraction(count) = NaN;
end
end

acc1 = accuracy + correct_side_dist1;
acc2 = accuracy + correct_side_dist1 + correct_side_dist2;
correctside = 1-wrong_side;

hold on
plot(thresh, acc2,'g-o','linewidth',2)
plot(thresh, acc1,'r-o','linewidth',2)
plot(thresh, accuracy,'b-o','linewidth',2)
plot(thresh, wrong_side,'k-o','linewidth',2)
plot(thresh, fraction,'c-o','linewidth',2)
legend('dist \leq 2', 'dist \leq 1', 'precise', 'wrong side', 'fraction');
xlabel('threshold');
%keyboard
returnfunction mfe = anti_inds_to_mfe(anti_inds)
% anti_inds holds for each nuc in the seq what is the index of
% the nuc across from it where the 0 means unpaired (this is returned by read_structure_withanti).
% returns mfe which is the structure in the format of rnafold, i.e. only base pairs:
% mfe is a 2 col matrix, the first being the bases on arm5 which are paired and the second
% their corresponding pairs
if(~iscell(anti_inds))
    mfe = get_mfe(anti_inds);
    return;
end
for i=1:length(anti_inds)
    mfe{i} = get_mfe(anti_inds{i});
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function mfe = get_mfe(ai)
bps=0;
for i=1:length(ai)
    if(ai(i))
        if(i>ai(i))
            return

```

```

    end
    bps = bps+1;
    mfe(bps,1) = i;
    mfe(bps,2) = ai(i);
end
end
function [sum_in_win, sum_in_win_mfe, sum_out, sum_out_mfe, faulty] = ...
    base_pairing(pal_len, bp_prob, mfe, winstart5, win_len)
% function [sum_in_win, sum_in_win_mfe, sum_out, sum_out_mfe, faulty] = ...
%   base_pairing(pal_len, bp_prob, mfe, winstart5, win_len)
% pal_len is length of palindrom
% bp_prob is the base pairing prob matrix which has 3 cols:
% 5side index, 3side index, prob to be paired
% mfe has the pairs in the min free energy drawing
% winstart5 is the position of the start of the window in question
% win_len is its length
% sum_in_win is the sum of the bp probs of all pairs involving a base
% in the designated window normalized by win_len
% sum_in_win_mfe is the sum of the bp probs of all pairs appearing
% in the mfe structure and involving a base in the window. this is
% normalized by the number of base pairs appearing in the mfe structure
% within the window (if only one folding possible sum_in_win_mfe=1).
% sum_out is like sum_in only all bases not in window. normalized by
% ((pal_len-eb_len)/2 - win_len).
% sum_out_mfe is like sum_in_win_mfe only for all bp not in window.
% analogous normalization.
% if window is illegal, returns faulty=1 and NAN for other values
% also note that no check is made on winstart5 and win_len being positive (which they must) - beware!
n_pairs = size(bp_prob,1);
n_mfe_pairs = size(mfe,1);
arm5 = mfe(:,1);
arm3 = mfe(:,2);
eb_start = arm5(end)+1;
eb_end = arm3(end)-1;
eb_len = eb_end-eb_start+1; % num nucs in end bulge
win_inds = [winstart5:winstart5+win_len-1];
if(any(intersect(win_inds,[eb_start:eb_end])) | win_inds(end)>pal_len)
    faulty = 1;
    sum_in_win = NaN;
    sum_in_win_mfe = NaN;
    sum_out = NaN;
    sum_out_mfe = NaN;
    disp('WINDOW IS ILLEGAL. RETURNING FAULTY=1. ');
    disp(['window has ' num2str(length(intersect(win_inds,[eb_start:eb_end]))) ' nucs in endloop']);
    return
end
sum_in_win = 0;
sum_in_win_mfe = 0;
sum_out = 0;
sum_out_mfe = 0;

```

```

faulty = 0;
n_mfe_pairs_inwin = 0;
for i=1:n_pairs
    side5 = bp_prob(i,1);
    side3 = bp_prob(i,2);
    if(ismembc(side5,win_inds) | ismembc(side3,win_inds))
        sum_in_win = sum_in_win + bp_prob(i,3);
        if(ismember([side5,side3],mfe,'rows'))
            sum_in_win_mfe = sum_in_win_mfe + bp_prob(i,3);
            n_mfe_pairs_inwin = n_mfe_pairs_inwin + 1;
        end
    else
        sum_out = sum_out + bp_prob(i,3);
        if(ismember([side5,side3],mfe,'rows'))
            sum_out_mfe = sum_out_mfe + bp_prob(i,3);
        end
    end
end
% normalization
sum_in_win = sum_in_win/win_len;
sum_in_win_mfe = sum_in_win_mfe/n_mfe_pairs_inwin;
sum_out = sum_out/((pal_len-eb_len)/2 - win_len);
sum_out_mfe = sum_out_mfe/(n_mfe_pairs-n_mfe_pairs_inwin);
function [sum_in_win, sum_out, faulty] = ...
    base_pairing_nomfe(pal_len, bp_prob, mfe, winstart5, win_len)
% function [sum_in_win, sum_out, faulty] = ...
%   base_pairing(pal_len, bp_prob, mfe, winstart5, win_len)
% same as base_pairing but only computes these outputs (much faster)
n_pairs = size(bp_prob,1);
n_mfe_pairs = size(mfe,1);
arm5 = mfe(:,1);
arm3 = mfe(:,2);
eb_start = arm5(end)+1;
eb_end = arm3(end)-1;
eb_len = eb_end-eb_start+1; % num nucs in end bulge
win_inds = [winstart5:winstart5+win_len-1];
if(any(intersect(win_inds,[eb_start:eb_end])) | win_inds(end)>pal_len)
    faulty = 1;
    sum_in_win = NaN;
    sum_out = NaN;
    disp('WINDOW IS ILLEGAL. RETURNING FAULTY=1.');
```

disp(['window has ' num2str(length(intersect(win\_inds,[eb\_start:eb\_end]))) ' nucs in endloop']);

```

    return
end
sum_in_win = 0;
sum_out = 0;
faulty = 0;
n_mfe_pairs_inwin = 0;
for i=1:n_pairs
    side5 = bp_prob(i,1);

```

```

side3 = bp_prob(i,2);
if(ismembc(side5,win_inds) | ismembc(side3,win_inds))
    sum_in_win = sum_in_win + bp_prob(i,3);
else
    sum_out = sum_out + bp_prob(i,3);
end
end
% normalization
sum_in_win = sum_in_win/win_len;
sum_out = sum_out/((pal_len-eb_len)/2 - win_len);
function [sum_in_win, sum_in_win_mfe, sum_out, sum_out_mfe, faulty] = ...
    base_pairing(pal_len, bp_prob, mfe, wstart5, win_len)
% function [sum_in_win, sum_in_win_mfe, sum_out, sum_out_mfe, faulty] = ...
%   base_pairing(pal_len, bp_prob, mfe, wstart5, win_len)
% pal_len is length of palindrom
% bp_prob is the base pairing prob matrix which has 3 cols:
% 5side index, 3side index, prob to be paired
% mfe has the pairs in the min free energy drawing
% wstart5 is the position of the start of the window in question
% win_len is its length
% sum_in_win is the sum of the bp probs of all pairs involving a base
% in the designated window normalized by win_len
% sum_in_win_mfe is the sum of the bp probs of all pairs appearing
% in the mfe structure and involving a base in the window. this is
% normalized by the number of base pairs appearing in the mfe structure
% within the window (if only one folding possible sum_in_win_mfe=1).
% sum_out is like sum_in only all bases not in window. normalized by
% ((pal_len-eb_len)/2 - win_len).
% sum_out_mfe is like sum_in_win_mfe only for all bp not in window.
% analogous normalization.
% if window is illegal, returns faulty=1 and NAN for other values
% also note that no check is made on wstart5 and win_len being positive (which they must) - beware!
n_pairs = size(bp_prob,1);
n_mfe_pairs = size(mfe,1);
arm5 = mfe(:,1);
arm3 = mfe(:,2);
eb_start = arm5(end)+1;
eb_end = arm3(end)-1;
eb_len = eb_end-eb_start+1; % num nucs in end bulge
win_inds = [wstart5:wstart5+win_len-1];
if(any(intersect(win_inds,[eb_start:eb_end])) | win_inds(end)>pal_len)
    faulty = 1;
    sum_in_win = NaN;
    sum_in_win_mfe = NaN;
    sum_out = NaN;
    sum_out_mfe = NaN;
    disp('WINDOW IS ILLEGAL. RETURNING FAULTY=1.');
```

disp(['window has ' num2str(length(intersect(win\_inds,[eb\_start:eb\_end]))) ' nucs in endloop']);

```

    return
end
end

```

```

sum_in_win = 0;
sum_in_win_mfe = 0;
sum_out = 0;
sum_out_mfe = 0;
faulty = 0;
n_mfe_pairs_inwin = 0;
for i=1:n_pairs
    side5 = bp_prob(i,1);
    side3 = bp_prob(i,2);
    if(ismember(side5,win_inds) | ismember(side3,win_inds))
        sum_in_win = sum_in_win + bp_prob(i,3);
        if(ismember([side5,side3],mfe,'rows'))
            sum_in_win_mfe = sum_in_win_mfe + bp_prob(i,3);
            n_mfe_pairs_inwin = n_mfe_pairs_inwin + 1;
        end
    else
        sum_out = sum_out + bp_prob(i,3);
        if(ismember([side5,side3],mfe,'rows'))
            sum_out_mfe = sum_out_mfe + bp_prob(i,3);
        end
    end
end
% normalization
sum_in_win = sum_in_win/win_len;
sum_in_win_mfe = sum_in_win_mfe/n_mfe_pairs_inwin;
sum_out = sum_out/((pal_len-eb_len)/2 - win_len);
sum_out_mfe = sum_out_mfe/(n_mfe_pairs-n_mfe_pairs_inwin);
function [sum_in_win, sum_in_win_mfe, sum_out, sum_out_mfe, faulty] = ...
    base_pairing2(pal_len, bp_prob, mfe, winstart5, win_len)
% function [sum_in_win, sum_in_win_mfe, sum_out, sum_out_mfe, faulty] = ...
%   base_pairing2(pal_len, bp_prob, mfe, winstart5, win_len)
% see base_pairing but here no normalization
n_pairs = size(bp_prob,1);
n_mfe_pairs = size(mfe,1);
arm5 = mfe(:,1);
arm3 = mfe(:,2);
eb_start = arm5(end)+1;
eb_end = arm3(end)-1;
eb_len = eb_end-eb_start+1; % num nucs in end bulge
win_inds = [winstart5:winstart5+win_len-1];
if(any(intersect(win_inds,[eb_start:eb_end])) | win_inds(end)>pal_len)
    faulty = 1;
    sum_in_win = NaN;
    sum_in_win_mfe = NaN;
    sum_out = NaN;
    sum_out_mfe = NaN;
    disp('WINDOW IS ILLEGAL. RETURNING FAULTY=1.');
```

disp(['window has ' num2str(length(intersect(win\_inds,[eb\_start:eb\_end]))) ' nucs in endloop']);

```

    return
end
end

```

```

sum_in_win = 0;
sum_in_win_mfe = 0;
sum_out = 0;
sum_out_mfe = 0;
faulty = 0;
n_mfe_pairs_inwin = 0;
for i=1:n_pairs
    side5 = bp_prob(i,1);
    side3 = bp_prob(i,2);
    if(ismembc(side5,win_inds) | ismembc(side3,win_inds))
        sum_in_win = sum_in_win + bp_prob(i,3);
        if(ismember([side5,side3],mfe,'rows'))
            sum_in_win_mfe = sum_in_win_mfe + bp_prob(i,3);
            n_mfe_pairs_inwin = n_mfe_pairs_inwin + 1;
        end
    else
        sum_out = sum_out + bp_prob(i,3);
        if(ismember([side5,side3],mfe,'rows'))
            sum_out_mfe = sum_out_mfe + bp_prob(i,3);
        end
    end
end
function [y, df] = chi2(table)
%[y, df] = chi2(table)
%calculate chi2 valuse for m*n table, with m,n>1
n = sum(table(:));
sum2 = sum(table,1);
sum1 = sum(table,2);
% calculate the expected vals , assuming independence
ex = 0;
for i1 = 1:size(table,1);
    for i2 = 1:size(table,2)
        ex(i1,i2) = sum1(i1) *sum2(i2)/n;
    end
end
if any(sum1 == 0) | any(sum2 == 0)
    y = NaN;
else
    y = sum(sum((ex-table).^2./ex));
end
df = (size(table,1)-1)*(size(table,2)-1);
return
function T=clusterize_prototype(seqs,maxd)
%T=clusterize_prototype(seqsd,maxd)
%clusterize by edist. all examples within cluster have edist < maxd.
%pick one prototype from each cluster
%T(i) = 1 if example i is to be used. T(i) = 0 if example i is to be ignored.
if ~all(isletter(seqs{1}))
    for i = 1:length(seqs)
        seqs{i} = int2nuc(seqs{i});
    end
end

```

```

    end
end
if length(seqs{1}) > 25
    disp('sequence is longer than 25. press enter to continue');
    pause
end
nseq=length(seqs);
%maxseq=ceil(nseq/Nc);
dij=zeros((nseq-1)*nseq/2,3);
count = 0;
for i=1:nseq-1
    for j=i+1:nseq
        count = count+1;
        dij(count,:)=editD(seqs{i},seqs{j}),i,j];
    end
end
sdij=sortrows(dij);
npair=length(sdij);
for i=1:nseq
    ss{i}=i;
end
iseq=[1:nseq];
s2g=iseq;
ng=ones(nseq,1);
Nc=0;
useg=[];
for i=1:npair
    gid=s2g(sdij(i,[2 3]));
    if ((diff(gid)~=0) & (sdij(i,1)<maxd))
        g=union(ss{gid});
        ss{gid(1)}=g;
        s2g(g)=gid(1);
        ng(g)=0;
        ng(gid(1))=length(g);
    end
end
end

ii=find(ng>0);
grp={ss{ii}};
T = zeros(1,length(seqs));
rand('state',121);
for i = 1:length(ii)
    s=ss{ii(i)};
    r=ceil(rand*length(s));
    T(s(r)) = 1;
end
return
function grp=clusterize_prototype1(seqs,maxd)
%T=clusterize_prototype1(seqsd,maxd)
%clusterize by edist. all examples within cluster have edist < maxd.

```

```

%grp is a cell array containing the cluster members
if ~all(isletter(seqs{1}))
    for i = 1:length(seqs)
        seqs{i} = int2nuc(seqs{i});
    end
end
if length(seqs{1}) > 25
    disp('sequence is longer than 25. press enter to continue');
    pause
end
nseq=length(seqs);
%maxseq=ceil(nseq/Nc);
dij=zeros(0.5*nseq*(nseq-1),3);
count = 0;
for i=1:nseq-1
    for j=i+1:nseq
        dij(count+1,:)= [editD(seqs{i},seqs{j}),i,j];
        count = count+1;
    end
end
sdij=sortrows(dij);
npair=length(sdij);
for i=1:nseq
    ss{i}=i;
end
iseq=[1:nseq];
s2g=iseq;
ng=ones(nseq,1);
Nc=0;
useg=[];
for i=1:npair
    gid=s2g(sdij(i,[2 3]));
    if ((diff(gid)~=0) & (sdij(i,1)<maxd))
        g=union(ss{gid});
        ss{gid(1)}=g;
        s2g(g)=gid(1);
        ng(g)=0;
        ng(gid(1))=length(g);
    end
end
ii=find(ng>0);
grp={ss{ii}};
T = zeros(1,length(seqs));
rand('state',121);
for i = 1:length(ii)
    s=ss{ii(i)};
    r=ceil(rand*length(s));
    T(s(r)) = 1;
end

```

```

return
overhang = 2;
clear set_name;
set_name = 'h104';
load_training_from_mat;
mir_win = get_win_pos_overhang_v1(anti_inds,pos,mirlen,overhang);
num_nan_wins = 0;
num_amb_wins = 0;
for i= 1:length(mir_win)
    w = mir_win{i};
    if(~isstruct(w))
        num_nan_wins = num_nan_wins+1;
    else
        if(w.ambiguous)
            num_amb_wins = num_amb_wins+1;
        end
    end
end
length(mir_win)
num_nan_wins
num_amb_wins
function create_file_for_rnastructure(seq,filename)
if(~isletter(seq(1)))
    seq=int2nuc(seq);
end
pause(1)
fid = fopen(filename,'w');
fprintf(fid,'\n1\n');
for i = 1:length(seq)
    fprintf(fid,seq(i));
end
fprintf(fid,'1\n');
fclose(fid);function h = entropy(p,base)
% function h = entropy(p,base)
% function h = entropy(p)
% computes the entropy of the distribution p in base base
% if no base is given assumes base 2
h = sum(-1*xlog2x(p));
if(nargin==2)
    h = h/log2(base);
end
%%%%%%%%%%

function y = xlog2x(x)
l = 1:length(x);
l0 = find(x==0);
y(l0) = 0;
l1 = setdiff(l,l0);
y(l1) = x(l1).*log2(x(l1));
function [anti_nucs,which_case] = get_anti_nucs(pos,pal_pos_bp,mfe)

```

```

% function anti_nucs = get_anti_nucs(pos,pal_pos_bp,mfe)
% pal_pos_bp is a vector of length pallen which holds the position of the nuc
% in the following format: all bp are numbered from legs by 1,2,3,...
% If a nuc is paired its pos_bp is the number of its bp. If not it is interpolated
% if the nuc is on the end loop pos_bp = 0.
% pos is the real position.
% anti_nucs gives the pos of the nuc across from pos. in some cases gives a few options.
% which_case is a string signaling the case:
% end_loop - pos sits on endloop, anti_nucs=nan in this case.
% bp - base paired
% equal_bulge
% small_bulge
% large_bulge
% non_sym_bulge
% how to determine across:
% if paired - obvious
% if on bulge and across bulge of same length, corresponding on anti bulge
% if on bulge smaller than antibulge: all options that don't cross
% if on bulge larger than antibulge and antibulge not empty: corresponding to
% all options that dont cross
% if on bulge and no bulge across: to closest bp across(if exactly in middle gives both option)
pallen = length(pal_pos_bp);
eb_start = mfe(end,1)+1;
eb_end = mfe(end,2)-1;
if(intersect([eb_start:eb_end],pos))
    %warning(['get_anti_nucs: pos sits on endloop. returning NAN. (pos = ' num2str(pos) ')']);
    anti_nucs = nan;
    which_case = 'end_loop';
    return;
end
if(pos<1 | pos>pallen)
    %warning(['get_anti_nucs: pos sits outside of pal. returning NAN. (pos = ' num2str(pos) ')']);
    anti_nucs = nan;
    which_case = 'outside pal';
    return;
end
pos_bp = pal_pos_bp(pos); % bp number of nuc in question
mod_pos_bp = mod(pos_bp,1);
if(mod_pos_bp==0) % nuc is paired
    this_pair = mfe(pos_bp,:);
    tt = find(this_pair == pos);
    anti_nucs = this_pair(setdiff([1:2],tt));
    which_case = 'bp';
    return;
end
% from here means nuc is unpaired
pos_side = 2-(pos<eb_start); % 1 for arm5, 2 for arm3.
pos_anti_side = setdiff([1:2],pos_side);
if(pos_side==1)
    my_side_inds = 1:eb_start-1;

```

```

else
    my_side_inds = eb_end+1:pallen;
end
bp_before = pos_bp - mod_pos_bp;
bp_after = bp_before + 1;
if(bp_before>0)
    num_in_my_bulge = abs(mfe(bp_after,pos_side) - mfe(bp_before,pos_side))-1;
    num_in_anti_bulge = abs(mfe(bp_after,pos_anti_side) - mfe(bp_before,pos_anti_side))-1;
else
    num_in_my_bulge = min(mfe(bp_after,pos_side)-1,abs(mfe(bp_after,pos_side)-pallen));
    num_in_anti_bulge = min(mfe(bp_after,pos_anti_side)-1,abs(mfe(bp_after,pos_anti_side)-pallen));
end
if(num_in_my_bulge == num_in_anti_bulge)
    tt = find(pal_pos_bp==pos_bp);
    anti_nucs = setdiff(tt,pos);
    which_case = 'equal_bulge';
    return;
end
my_bulge_vec = linspace(bp_before,bp_after,num_in_my_bulge+2);
my_bulge_vec = my_bulge_vec(2:end-1);
anti_bulge_vec = linspace(bp_before,bp_after,num_in_anti_bulge+2);
anti_bulge_vec = anti_bulge_vec(2:end-1);
my_place = find(my_bulge_vec==pos_bp);
if(num_in_my_bulge < num_in_anti_bulge)
    for i=1:(num_in_anti_bulge-num_in_my_bulge+1)
        tt = find(pal_pos_bp == anti_bulge_vec(my_place+i-1));
        % make sure not finding anything in my_bulge (that is look only in other side):
        anti_nucs(i) = setdiff(tt,my_side_inds);
    end
    which_case = 'small_bulge';
    return;
end
if((num_in_my_bulge > num_in_anti_bulge) & num_in_anti_bulge>0)
    anti_nucs = [];
    for i=1:(num_in_my_bulge-num_in_anti_bulge+1)
        tt = my_place-i+1;
        if(tt>0 & tt<=num_in_anti_bulge)
            ttt = find(pal_pos_bp == anti_bulge_vec(tt));
            % make sure not finding anything in my_bulge (that is look only in other side):
            anti_nucs = [anti_nucs,setdiff(ttt,my_side_inds)];
        end
    end
    which_case = 'large_bulge';
    return;
end
if(num_in_anti_bulge == 0)
    if(mod_pos_bp==0.5)
        anti_nucs(1) = mfe(bp_after,pos_anti_side);
        if(bp_before>0)
            anti_nucs(2) = mfe(bp_before,pos_anti_side);
        end
    end
end

```

```

    end
elseif(mod_pos_bp<0.5 & bp_before>0)
    anti_nucs = mfe(bp_before,pos_anti_side);
else
    anti_nucs = mfe(bp_after,pos_anti_side);
end
which_case = 'non_sym_bulge';
return;
end
% really shouldn't be here
error('terrible mistake... aborting');

function [energy,mfe] = get_from_ct(ct_file)
% gets the energy and mfe of first zucker fold as outputted from rnastructure
% caution: relies on the very specific format of the out file ct_file - check!
ct_file
fid = fopen(ct_file,'r');
if(fid==-1)
    keyboard
end
line = fgetl(fid);
x = findstr('ENERGY',line);
if isempty(x)
    energy = 0;
    mfe = [];
    fclose(fid);
    return;
end
seqlen = str2num(line(1:x-1));
x = findstr('=',line);
ll = line(x+2:end);
x = findstr(' ',ll);
energy_s = ll(1:x);
energy = str2num(energy_s);
count = 0;
for i=1:seqlen
    line = fgetl(fid);
    v = str2num(line(8:end));
    across = v(3);
    if(across>0 & across<i)
        % already redundant info
        break;
    end
    if(across>0)
        count = count+1;
        mfe(count,1) = i;
        mfe(count,2) = across;
    end
end
fclose(fid);

```

```

function pos_bp = get_pos_bp(anti_inds)
% function pos_bp = get_pos_bp(anti_inds)
% pos_bp{i} is a vector of length pallen(i) holding the position of the nuc
% in the following format: all bp are numbered from legs by 1,2,3,...
% If a nuc is paired its pos_bp is the number of its bp. If not it is interpolated
% if the nuc is on the end loop pos_bp = 0
vec_flag = 0;
if(~iscell(anti_inds))
    tt{1} = anti_inds;
    anti_inds = tt;
    vec_flag = 1;
end
for i=1:length(anti_inds)
    ai = anti_inds{i};
    pallen = length(ai);
    mfe = anti_inds_to_mfe(ai);
    this_pos_bp = zeros(1,pallen);
    arm5 = mfe(:,1);
    arm3 = mfe(:,2);
    eb_start = arm5(end)+1;
    eb_end = arm3(end)-1;
    eb_len = eb_end-eb_start+1; % num nucs in end bulge

    this_pos_bp(arm5(1)) = 1;
    this_pos_bp(arm3(1)) = 1;
    d5 = arm5(1)-1;
    for k=1:d5
        this_pos_bp(k) = k/(d5+1);
    end
    d3 = pallen-arm3(1);
    for k=1:d3
        this_pos_bp(arm3(1)+k) = (d3+1-k)/(d3+1);
    end
    for j=2:length(arm5)
        this_pos_bp(arm5(j)) = j;
        this_pos_bp(arm3(j)) = j;
        d5 = arm5(j)-arm5(j-1)-1; %how many nucs in bulge between them
        for k=1:d5
            this_pos_bp(arm5(j-1)+k) = j-1 + k/(d5+1);
        end
        d3 = arm3(j-1)-arm3(j)-1;
        for k=1:d3
            this_pos_bp(arm3(j)+k) = j-1 + (d3+1-k)/(d3+1);
        end
    end
    pos_bp{i} = this_pos_bp;
end
if(vec_flag)
    tt = pos_bp{1};
    pos_bp = tt;
end

```

```

end
function win_mirpos = get_win_pos_v1(mfes,anti_inds,mirpos,mirlen)
% function win_mirpos = get_win_pos(mfes,anti_inds,mirpos,mirlen)
% returns win_mirpos in index of basepair (from legs not loop).
% i.e. mfe(win_mirpos,1) is the nuc pos on the 5 arm
% for mir on arm3 returns the closest bp from its mirpos towards the legs
% for mir on arm5 returns the closest bp from its END (mirpos+mirlen-1) towards the legs
% also towards the legs
for i=1:length(mirpos)
    pos5 = mirpos(i);
    pos3 = pos5+mirlen(i)-1;
    mfe = mfes{i};
    arm5 = mfe(:,1);
    arm3 = mfe(:,2);
    eb_start = arm5(end)+1;
    eb_end = arm3(end)-1;
    eb_len = eb_end-eb_start+1;
    side5 = (pos5<eb_start);
    ai = anti_inds{i};
    is_paired = (ai~=0);
    if(side5)
        k=0;
        while(~is_paired(pos3-k))
            k=k+1;
        end
        win_mirpos(i) = find(arm5==(pos3-k));
    else
        k=0;
        while(~is_paired(pos5+k))
            k=k+1;
        end
        win_mirpos(i) = find(arm3==(pos5+k));
    end
    if isempty(win_mirpos(i)))
        error('get_win_pos: fatal error. aborting.');
```

```

end
end
function win_mirpos = get_win_pos_v2(mfes,anti_inds,mirpos,mirlen)
% function win_mirpos = get_win_pos(mfes,anti_inds,mirpos,mirlen)
% returns win_mirpos in index of basepair (from legs not loop).
% i.e. mfe(win_mirpos,1) is the nuc pos on the 5 arm
% for mir on arm3 returns the closest bp from its mirpos towards the loop
% for mir on arm5 returns the closest bp from its END towards the loop (mirpos+mirlen-1)
% also towards the legs
for i=1:length(mirpos)
    pos5 = mirpos(i);
    pos3 = pos5+mirlen(i)-1;
    mfe = mfes{i};
    arm5 = mfe(:,1);
    arm3 = mfe(:,2);

```

```

eb_start = arm5(end)+1;
eb_end = arm3(end)-1;
eb_len = eb_end-eb_start+1;
side5 = (pos5<eb_start);
ai = anti_inds{i};
is_paired = (ai~=0);
if(side5)
    k=0;
    while(~is_paired(pos3+k))
        k=k+1;
    end
    tt = find(arm5==(pos3+k));
    if(tt)
        win_mirpos(i) = tt;
    else
        win_mirpos(i) = nan;
        disp(['mir ' num2str(i) ' intersects with loop - returning win_mirpos nan']);
    end
else
    k=0;
    while(~is_paired(pos5-k))
        k=k+1;
    end
    tt = find(arm3==(pos5-k));
    if(tt)
        win_mirpos(i) = tt;
    else
        win_mirpos(i) = nan;
        disp(['mir ' num2str(i) ' intersects with loop - returning win_mirpos nan']);
    end
end
end
if(isempty(win_mirpos(i)))
    error('get_win_pos: fatal error. aborting.');
```

```

end
if(ismember(pos5,eb_start:eb_end) | ismember(pos3,eb_start:eb_end))
    end
end

function win_mirpos = get_win_pos_v3(mfes,anti_inds,mirpos,mirlen)
% function win_mirpos = get_win_pos_v3(mfes,anti_inds,mirpos,mirlen)
% returns win_mirpos in index of basepair (from legs not loop).
% i.e. mfe(win_mirpos,1) is the nuc pos on the 5 arm
% for mir on arm3 returns the closest bp from its END (mirpos+mirlen-1) towards the LOOP
% for mir on arm5 returns the closest bp from its mirpos towards the LOOP
% also towards the legs
for i=1:length(mirpos)
    pos5 = mirpos(i);
    pos3 = pos5+mirlen(i)-1;
    mfe = mfes{i};
    arm5 = mfe(:,1);
    arm3 = mfe(:,2);

```

```

eb_start = arm5(end)+1;
eb_end = arm3(end)-1;
eb_len = eb_end-eb_start+1;
side5 = (pos5<eb_start);
ai = anti_inds{i};
is_paired = (ai~=0);
if(side5)
    k=0;
    while(~is_paired(pos5+k))
        k=k+1;
    end
    win_mirpos(i) = find(arm5==(pos5+k));
else
    k=0;
    while(~is_paired(pos3-k))
        k=k+1;
    end
    win_mirpos(i) = find(arm3==(pos3-k));
end
if isempty(win_mirpos(i)))
    error('get_win_pos: fatal error. aborting.');
```

end

```

end
function get_zuker_draw_by_number(drawfile,n)
% function get_zuker_draw_by_number(drawfile,n)
% given a file of zuker draws and a number, spills on the workspace the
% zuker draw number n in the file
fid = fopen(drawfile,'r');
ind = 0;
found_flag = 0;
while (~feof(fid) & found_flag==0)
    ind = ind + 1; % index going to read now
    if(ind==n)
        found_flag==1;
        disp('.')
        for i = 1:4
            line = fgetl(fid);
            disp(line);
        end
        disp('.');
    else
        for i = 1:4
            line = fgetl(fid);
        end
    end
end
fclose(fid);function strseq = int2nuc(intseq, ncase)
%strseq = int2nuc(intseq, ncase)
%convert a sequence of '1 2 3 4' into 'A C T G' or 'a c t g'
% ncase = uppercase | lowercase
```

```

if(isletter(intseq(1)))
    strseq = intseq;
    return;
end
if nargin == 1
    ncase = 'uppercase';
end
if strcmp(ncase,'uppercase')
    nucs = 'ACTG';
elseif strcmp(ncase,'lowercase')
    nucs = 'actg';
end
strseq = char(size(intseq));
for i = 1:length(intseq)
    strseq(i) = nucs(intseq(i));
end
return
function [yside, yprec2] = interpolate_prob_new(score, fitfile);
%[yside, yprec2] = interpolate_prob_new(score, fitfile);
% load the parameters for interpolation
load(fitfile);
%interpolate
yside = interp1(xs,ys,score,'linear');
yprec2 = interp1(xp2,yp2,score,'linear');
% extrapolate if necessary
if(min(xs)==xs(1)) % x is increasing
    yside(score<xs(1)) = ys(1);
    yprec2(score<xp2(1)) = yp2(1);
    yside(score>xs(end)) = ys(end);
    yprec2(score>xp2(end)) = yp2(end);
else % x is decreasing
    yside(score>xs(1)) = ys(1);
    yprec2(score>xp2(1)) = yp2(1);
    yside(score<xs(end)) = ys(end);
    yprec2(score<xp2(end)) = yp2(end);
end
returnfunction [yside, yprec2] = interpolate_prob_new_txt(score, fitfile);
%[yside, yprec2] = interpolate_prob_new(score, fitfile);
% fitfile is a text file
% load the parameters for interpolation
fid = fopen(fitfile,'r');
while ~feof(fid)
    line = fgetl(fid);
    if ~isstr(line), break, end;
    eval(line)
end
fclose(fid);
%interpolate
yside = interp1(xs,ys,score,'linear');
yprec2 = interp1(xp2,yp2,score,'linear');

```

```

% extrapolate if necessary
if(min(xs)==xs(1)) % x is increasing
    yside(score<xs(1)) = ys(1);
    yprec2(score<xp2(1)) = yp2(1);
    yside(score>xs(end)) = ys(end);
    yprec2(score>xp2(end)) = yp2(end);
else % x is decreasing
    yside(score>xs(1)) = ys(1);
    yprec2(score>xp2(1)) = yp2(1);
    yside(score<xs(end)) = ys(end);
    yprec2(score<xp2(end)) = yp2(end);
end
returnfunction [ry,ry_unique,mass,newx,newy,pos] = isotonic_regression(x,y)
% function [ry,ry_unique,mass,newx,neyy,pos] = isotonic_regression(x,y)
% first uniques x and attaches to it a y which the average of all y's
% attached to same x value (returns these new x and y).
% Also returns the "mass" of each point, so if a few points had the
% same x they are now lumped to one point, whose newy is the mean of
% the original ys.
% ry_unique is the regression of the "uniqued points". ry retains the
% dimensionality of the data.
% pos is such that sort(x)=newx(pos)
% (newx,ry_unique) are the new points. i.e they are sorted x's s.t. each x
% has one point y attached which is monotonous (the result of the IR).
% short short description: after running this function use as the new vectors
% newx and ry_unique
x=x(:); y=y(:);
oldx=x;
oldy=y;
if(length(x)~=length(y))
    disp('x and y must be of same length');
    return;
end
% sort the data according to x
[x,sortind]=sort(x);
y=y(sortind);
% first find avg of y's corresponding to the same x:
[x ndx pos]=unique(x);
mass=diff([0;ndx]); % uses the fact that x is sorted!!!!
counter=1;
for t=1:length(x)
    y(t)=mean(y(counter:counter+mass(t)-1));
    counter=counter+mass(t);
end
y(length(x)+1:length(y))=[];
ry=zeros(size(x));
ry(1)=y(1);
for i=2:length(x)

    ry(i)=y(i);

```

```

j=i;
while(j>1)
    if(ry(j)>=ry(j-1)) break; end
    newy=sum(mass(j-1:i).*ry(j-1:i))/sum(mass(j-1:i));
    ry(j-1:i)=newy;
    j=j-1;
end % while

end % i loop
ry_unique=ry;
ry=zeros(size(oldy));
counter=1;
for t=1:length(ry_unique)
    for j=1:mass(t)
        rytmp(counter)=ry_unique(t);
        counter=counter+1;
    end
end
ry(sortind)=rytmp;
newx=x;
newy=y;
data_dir = 'data_baseline_13_4';
%data_dir = 'data_baseline_15_5';
%data_dir = 'data_baseline_15_5\edist_above_87';
if(~exist('set_name'))
    %set_name = 'edist_above_87';
    set_name = 'h121';
end
if ~exist('randomize')
    randomize = 0;
end
if ~exist('remove_duplicate_mirs')
    remove_duplicate_mirs = 0;
end
palfile = ['c:\rosetta\' data_dir \'zucker_draw_' set_name '.txt'];
[seqs,anti_inds,bulges1,bulges2,endbulges,seq_id] = read_structure_withanti(palfile);
mirseqfile = ['c:\rosetta\' data_dir \'dicerseq_' set_name '.txt'];
[mirseqs,mirlen] = read_seq(mirseqfile);
pos = locate_dicer(mirseqs,seqs);
if randomize
    rand('state',sum(100*clock));
    disp('performing randomized permutation');
    l = randperm(length(seqs));
    bulges1 = bulges1(l);
    bulges2 = bulges2(l);
    anti_inds = anti_inds(l);
    endbulges = endbulges(l);
    mirlen = mirlen(l);
    pos = pos(l);
    seq_id = seq_id(l);

```

```

seqs = seqs(l);
mirseqs = mirseqs(l);
end
if remove_duplicate_mirs
    disp('removing duplicate mirs');
    D = zeros(length(seqs),1); % list of duplicate mirs
    for i = 1:length(seqs)
        for j = i+1:length(seqs)
            if length(mirseqs{j}) == length(mirseqs{i})
                if all(mirseqs{j} == mirseqs{i})
                    D(j) = 1;
                    break;
                end
            end
        end
    end
end
l = find(D);
bulges1(l) = [];
bulges2(l) = [];
anti_inds(l) = [];
endbulges(l) = [];
mirlen(l) = [];
pos(l) = [];
seq_id(l) = [];
seqs(l) = [];
mirseqs(l) = [];
end
lend=mirlen; % some applications use lend and not mirlen.
data_dir = 'data_baseline_15_5';
if(~exist('set_name'))
    set_name = 'hmdc294';
end
filename = ['c:\rosetta\' data_dir \vars_\' set_name]
load(filename);
mirlen = lend;if(~exist('d'))
    d = 'h121';
end
if ~exist('randomize')
    randomize = 1;
end
if ~exist('remove_duplicate_mirs')
    remove_duplicate_mirs = 1;
end
palseqfile = ['c:\rosetta\data_baseline_13_4\palseq_' d '.txt'];
[seqs,pallen] = read_seq(palseqfile);
mirseqfile = ['c:\rosetta\data_baseline_13_4\dicerseq_' d '.txt'];
[mirseqs,mirlen] = read_seq(mirseqfile);
pos = locate_dicer(mirseqs,seqs);
palmfefeile = ['c:\rosetta\data_baseline_13_4\mfe_structure_' d '.txt'];
[mfes,anti_inds,bulges1,bulges2,endbulges,seq_id]= ...

```

```

    read_structure_from_mfe(palmfefile);
palbpfile = ['c:\rosetta\data_baseline_13_4\bp_prob_' d '.txt'];
[bp_probs,len] = read_bp(palbpfile);
if randomize
    rand('state',sum(100*clock));
    disp('performing randomized permutation');
    l = randperm(length(seqs));
    bulges1 = bulges1(l);
    bulges2 = bulges2(l);
    endbulges = endbulges(l);
    pallen = pallen(l);
    mirlen = mirlen(l);
    pos = pos(l);
    seq_id = seq_id(l);
    seqs = seqs(l);
    mirseqs = mirseqs(l);
    mfes = mfes(l);
    bp_probs = bp_probs(l);
    anti_inds = anti_inds(l);
end
if remove_duplicate_mirs
    disp('removing duplicate mirs');
    D = zeros(length(seqs),1); % list of duplicate mirs
    for i = 1:length(seqs)
        for j = i+1:length(seqs)
            if length(mirseqs{j}) == length(mirseqs{i})
                if all(mirseqs{j} == mirseqs{i})
                    D(j) = 1;
                    break;
                end
            end
        end
    end
    l = find(D);
    bulges1(l) = [];
    bulges2(l) = [];
    endbulges(l) = [];
    mirlen(l) = [];
    pallen(l) = [];
    pos(l) = [];
    seq_id(l) = [];
    seqs(l) = [];
    mirseqs(l) = [];
    mfes(l) = [];
    bp_probs(l) = [];
    anti_inds(l) = [];
end
data_dir = 'data_baseline_29_7';
if(~exist('set_name'))
    set_name = 'h156';
end

```

```

end
if ~exist('randomize')
    randomize = 0;
end
if ~exist('remove_duplicate_mirs')
    remove_duplicate_mirs = 0;
end
palfile = ['c:\rosetta\' data_dir \'zucker_draw_' set_name '.txt'];
fid = fopen(palfile,'r');
[seqs,anti_inds,bulges1,bulges2,endbulges,pal_ids,energy,all_pal_ids] = ...
    read_structure_with_id_fid(fid,10000000000);
fclose(fid);
mirseqfile = ['c:\rosetta\' data_dir \'mirseq_' set_name '.txt'];
[mirseqs,mirlen,mir_ids,all_mir_ids] = read_seq_with_id(mirseqfile);
if(length(all_mir_ids)~=length(all_pal_ids) | any(all_mir_ids-all_pal_ids))
    error('ids in palfile and mirfile must match and be in same order');
end
if(length(mir_ids)~=length(pal_ids) | any(mir_ids-pal_ids))
    error('in one of the files (mir or pal) there was an illegal sequence not illegal in other file');
end
pos = locate_dicer(mirseqs,seqs);
if randomize
    rand('state',sum(100*clock));
    disp('performing randomized permutation');
    l = randperm(length(seqs));
    bulges1 = bulges1(l);
    bulges2 = bulges2(l);
    anti_inds = anti_inds(l);
    endbulges = endbulges(l);
    mirlen = mirlen(l);
    pos = pos(l);
    pal_ids = pal_ids(l);
    seqs = seqs(l);
    mirseqs = mirseqs(l);
    mir_ids = mir_ids(l);
end
if remove_duplicate_mirs
    disp('removing duplicate mirs');
    D = zeros(length(seqs),1); % list of duplicate mirs
    for i = 1:length(seqs)
        for j = i+1:length(seqs)
            if length(mirseqs{j}) == length(mirseqs{i})
                if all(mirseqs{j} == mirseqs{i})
                    D(j) = 1;
                    break;
                end
            end
        end
    end
end
I = find(D);

```

```

bulges1(l) = [];
bulges2(l) = [];
anti_inds(l) = [];
endbulges(l) = [];
mirlen(l) = [];
pos(l) = [];
pal_ids(l) = [];
seqs(l) = [];
mirseqs(l) = [];
mir_ids(l) = [];
end
lend=mirlen; % some applications use lend and not mirlen.
function pos = locate_dicer(dicer_seq,pal_seq);
%pos = locate_dicer(dicer_seq,palseq)
%get absolute position of dicer on palindrom, from the beginning of the palindrom
if length(dicer_seq) ~= length(pal_seq)
    error('different number of sequences');
end
%convert to nucleotide-format if in int format
if all(~isletter(pal_seq{1}))
    for i = 1:length(pal_seq)
        pal_seq{i} = int2nuc(pal_seq{i},'uppercase');
    end
end
if all(~isletter(dicer_seq{1}))
    for i = 1:length(dicer_seq)
        dicer_seq{i} = int2nuc(dicer_seq{i},'uppercase');
    end
end
pos = zeros(1,length(dicer_seq));
for i = 1:length(dicer_seq)
    l = findstr(dicer_seq{i}, pal_seq{i});
    if length(l) == 1
        pos(i) = l;
    else
        pos(i) = NaN;
    end
end
function y = meannan(x)
if(min(size(x))==1)
    y = mean(x(~isnan(x)));
    return;
end
y = zeros(1,size(x,2));
for i=1:size(x,2)
    v = x(:,i);
    y(i) = mean(v(~isnan(v)));
end
function seqsbp = nuc2bp(seqs,anti_inds,base_pair_basis)
%seqsbp = nuc2bp(seqs,anti_inds,base_pair_basis)

```

```

%transform to base pair representation
%for a 3 state model {AT,CG,TG} -> 1 2 3
%for a 6 state {AT,CG,TG,TA,GC,GT} -> 1 2 3 4 5 6
%also works if seqs is a vector and not a cell array, in which case returns a vector
if(~iscell(seqs))
    tt{1} = seqs;
    seqs = tt;
    tt{1} = anti_inds;
    anti_inds = tt;
    vecflag = 1;
else
    vecflag = 0;
end
map = zeros(4);
map(1,3) = 1; %AT
map(2,4) = 2; %CG
map(3,4) = 3; %TG
if base_pair_basis == 3
    map = map+map';
else
    map(3,1) = 4; %AT
    map(4,2) = 5; %CG
    map(4,3) = 6; %TG
end
seqsbp = cell(size(seqs));
for i = 1:length(seqs)
    seqsi = seqs{i};
    seqsbpi = zeros(size(seqsi));
    anti_indsi = anti_inds{i};

    I = find(anti_indsi ~= 0);
    for j = 1:length(I)
        ij = I(j);
        seqsbpi(ij) = map(seqsi(ij),seqsi(anti_indsi(ij)));
    end
    seqsbp{i} = seqsbpi;
end
if(vecflag)
    tt=seqsbp{1};
    seqsbp = tt;
end
return
function [intseq, fault_seq] = nuc2int(strseq);
%[intseq, fault_seq] = nuc2int(strseq)
%convert a sequence of 'A C T G' into a array of 1 2 3 4
if(~isletter(strseq(1)))
    intseq = strseq;
    fault_seq = 0;
    return;
end

```

```

intseq = zeros(size(strseq));
fault_seq = 0;
for i = 1:length(strseq)
    switch upper(strseq(i))
        case 'A' , intseq(i) = 1;
        case 'C' , intseq(i) = 2;
        case 'T' , intseq(i) = 3;
        case 'G' , intseq(i) = 4;
        otherwise , intseq = []; fault_seq = 1; break;
    end
end
function intseq = nuc2int4(strseq)
%convert a sequence of 'A C T G' into a array of 1 2 3 4
strseq = deblank(strseq);
intseq = zeros(size(strseq));
for i = 1:length(strseq)
    switch upper(strseq(i))
        case 'A' , intseq(i) = 1;
        case 'C' , intseq(i) = 2;
        case 'T' , intseq(i) = 3;
        case 'G' , intseq(i) = 4;
        otherwise , intseq(i) = [];
    end
end
function [intseq, fault_seq] = nuc2int4_new(strseq);
%[intseq, fault_seq] = nuc2int4_new(strseq)
%convert a sequence of 'A C T G' into a array of 1 2 3 4
intseq = zeros(size(strseq));
fault_seq = 0;
for i = 1:length(strseq)
    switch upper(strseq(i))
        case 'A' , intseq(i) = 1;
        case 'C' , intseq(i) = 2;
        case 'T' , intseq(i) = 3;
        case 'G' , intseq(i) = 4;
        otherwise , intseq = []; fault_seq = 1; break;
    end
end
function [seqs,anti_inds,bulges_nonsym,bulges_sym,endbulges,pal_id,energy,all_pal_ids] =
read_structure_with_id_fid(fid,seqtot)
% function [seqs,anti_inds,bulges_nonsym,bulges_sym,endbulges,pal_id,energy,all_pal_ids] =
read_structure_with_id_fid(fid,seqtot)
% same as read_structure_withanti_fid but reads file that have before the 4 line zucker draw
% a line giving the pal_id and a line giving the energy.
% all_pal_ids is all ids read from file, whether faulty or not
% new feature: checks that draw is not messed up and if it is gives faulty seq.
Mxplen = 250; % maximal length of palindrom
counter = 0;
seq_no = 0;
seqs = cell(0);

```

```

bulges_nonsym= cell(0);
bulges_sym= cell(0);
endbulges = cell(0);
pal_id = zeros(0);
energy = zeros(0);
next_pal_id = str2double(fgetl(fid));
while ~feof(fid) & seq_no < seqtot
    this_pal_id = next_pal_id;
    this_energy = str2double(fgetl(fid));
    structure = char(4,250);
    i = 0;
    line = fgetl(fid);
    fault_seq_emptyline = 0;
    while((line~-1 & isnan(str2double(line))) | isempty(line))
        if(isempty(line))
            fault_seq_emptyline = 1;
        end
        i = i+1;
        structure(i,1:length(line)) = line;
        line = fgetl(fid);
    end
    if(~feof(fid))
        next_pal_id = str2double(line);
    end
    if(i~=4)
        fault_seq_numlines = 1;
    else
        fault_seq_numlines = 0;
    end

    fault_seq_struct = 1; % guilty until proven innocent
    fault_seq_nuc = 1;
    if(fault_seq_numlines == 0 & fault_seq_emptyline==0)
        [seqi, anti_indi, bulge1i, bulge2i, endbulgei,fault_seq_struct] = get_features(structure);
        if(fault_seq_struct==0)
            % this is the old bulge1 and bulge2, now need to correct that
            bulge_nonsymi=bulge1i;
            bulge_symi=bulge2i;
            for j = 1:length(seqi)
                if(bulge_nonsymi(j))
                    if(bulge_symi(max(1,j-1))) % a neighbor has a bulgesym flag on
                        bulge_symi(j) = 1;
                        bulge_nonsymi(j) = 0;
                    end
                end
            end
            for j = length(seqi):-1:1
                if(bulge_nonsymi(j))
                    if(bulge_symi(min(j+1,length(seqi)))) % a neighbor has a bulgesym flag on
                        bulge_symi(j) = 1;

```

```

        bulge_nonsymi(j) = 0;
    end
end
end
end
[intseq, fault_seq_nuc] = nuc2int4_new(seqi);
end

if (fault_seq_struct == 0 & fault_seq_nuc == 0 & fault_seq_numlines == 0 & fault_seq_emptyline == 0)
    seq_no = seq_no + 1;
    seqs{seq_no} = intseq;
    anti_inds{seq_no} = anti_indi;
    bulges_nonsym{seq_no} = bulge_nonsymi;
    bulges_sym{seq_no} = bulge_symi;
    endbulges{seq_no} = endbulgei;
    pal_id(seq_no) = this_pal_id;
    energy(seq_no) = this_energy;
    counter = counter + 1;
    all_pal_ids(counter) = this_pal_id;
else
    disp(['faulty seq on pal id ' num2str(this_pal_id)])
    if(fault_seq_emptyline)
        disp(['reason is that there was an empty line in zucker']);
    elseif(fault_seq_numlines)
        disp(['reason is that there were not 4 lines in the draw']);
    elseif(fault_seq_struct)
        disp(['reason is that draw was messed has nuc in pair and bulge at the same time']);
    elseif(fault_seq_nuc)
        disp(['reason is that there was an illegal letter in the seq']);
    end
    counter = counter + 1;
    all_pal_ids(counter) = this_pal_id;
end
end
return
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [seq, anti_ind, bulge1, bulge2, endbulge, fault_seq] = get_features(structure)
% get sequence as well as bulge structure
fault_seq = 0;
%upper half (5' side)
bulge_row = 1; % the row of bulge letters
bulge_row_opposite = 4;
uphalf = structure(1:2,:);
[j,k] = find(isletter(uphalf));
max_col = max(k);
tmpmat = zeros(2,max_col);
count = 0;
for col = 1: max_col
    fl = find(isletter(uphalf(:,col)));

```

```

if (length(fl)>1);
    fault_seq = 1;
    seq=nan;anti_ind=nan;bulge1=nan;bulge2=nan;endbulge=nan;
    return;
end;
if ~isempty(fl)
    count = count + 1;
    seq(count) = uphalf(fl,col);
    bulge = (fl == bulge_row);
    if(bulge)
        tmpmat(1,col) = 0;
    else
        tmpmat(1,col) = count;
    end
    bulge1(count) = 0;
    bulge2(count) = 0;
    if bulge & isletter(structure(bulge_row_opposite,col))
        bulge2(count) = 1;
    elseif bulge & ~isletter(structure(bulge_row_opposite,col))
        bulge1(count) = 1;
    end
end
end
% endbulge is coded on the upper half
% go backwards from 3' side to 5' side
endbulge = zeros(size(bulge1));
lwhalf = structure(3:4,:);
pos = length(bulge1);
while bulge1(pos) == 1
    endbulge(pos) = 1;
    bulge1(pos) = 0;
    pos = pos - 1;
end
%lower half
bulge_row = 2; % 4 th line on structure is 2 line on lower half
bulge_row_opposite = 1;
[j,k] = find(isletter(lwhalf));
max_col = max(k);
for col =max_col:-1:1
    fl = find(isletter(lwhalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        seq(count) = lwhalf(fl,col);
        bulge = (fl == bulge_row);
        if(bulge)
            tmpmat(2,col) = 0;
        else
            tmpmat(2,col) = count;
        end
        bulge1(count) = 0;
    end
end

```

```

    bulge2(count) = 0;
    if bulge & isletter(structure(bulge_row_opposite,col))
        bulge2(count) = 1;
    elseif bulge & ~isletter(structure(bulge_row_opposite,col))
        bulge1(count) = 1;
    end
    endbulge(count) = 0;
end
end
anti_ind = zeros(size(bulge1));
for col=1:max_col
    if(tmpmat(1,col))
        anti_ind(tmpmat(1,col)) = tmpmat(2,col);
        anti_ind(tmpmat(2,col)) = tmpmat(1,col);
    end
end
return
function [seqs,anti_inds,bulges_nonsym,bulges_sym,endbulges,pal_id,energy,all_pal_ids] =
read_structure_with_id_fid_ce(fid,seqtot)
% function [seqs,anti_inds,bulges_nonsym,bulges_sym,endbulges,pal_id,energy,all_pal_ids] =
read_structure_with_id_fid_ce(fid,seqtot)
% same as read_structure_withanti_fid but reads file that have before the 4 line zucker draw
% a line giving the pal_id and a line giving the energy.
% all_pal_ids is all ids read from file, whether faulty or not
% new feature: checks that draw is not messed up and if it is gives faulty seq.
% in this check_e version returns faulty seq also when no energy found
Mxplen = 250; % maximal length of palindrom
counter = 0;
seq_no = 0;
seqs = cell(0);
bulges_nonsym= cell(0);
bulges_sym= cell(0);
endbulges = cell(0);
pal_id = zeros(0);
energy = zeros(0);
next_pal_id = str2double(fgetl(fid));
while ~feof(fid) & seq_no < seqtot
    this_pal_id = next_pal_id;
    this_energy = str2double(fgetl(fid));
    if(isnan(this_energy))
        fault_seq_energy = 1;
    else
        fault_seq_energy = 0;
    end
    structure = char(4,250);
    i = 0;
    line = fgetl(fid);
    fault_seq_emptyline = 0;
    while((line~-1 & isnan(str2double(line))) | isempty(line))
        if(isempty(line))

```

```

        fault_seq_emptyline = 1;
    end
    i = i+1;
    structure(i,1:length(line)) = line;
    line = fgetl(fid);
end
if(~feof(fid))
    next_pal_id = str2double(line);
end
if(i~=4)
    fault_seq_numlines = 1;
else
    fault_seq_numlines = 0;
end

fault_seq_struct = 1; % guilty until proven innocent
fault_seq_nuc = 1;
if(fault_seq_numlines == 0 & fault_seq_emptyline==0 & fault_seq_energy==0)
    [seqi, anti_indi, bulge1i, bulge2i, endbulgei,fault_seq_struct] = get_features(structure);
    if(fault_seq_struct==0)
        % this is the old bulge1 and bulge2, now need to correct that
        bulge_nonsymi=bulge1i;
        bulge_symi=bulge2i;
        for j = 1:length(seqi)
            if(bulge_nonsymi(j))
                if(bulge_symi(max(1,j-1))) % a neighbor has a bulgesym flag on
                    bulge_symi(j) = 1;
                    bulge_nonsymi(j) = 0;
                end
            end
        end
        for j = length(seqi):-1:1
            if(bulge_nonsymi(j))
                if(bulge_symi(min(j+1,length(seqi)))) % a neighbor has a bulgesym flag on
                    bulge_symi(j) = 1;
                    bulge_nonsymi(j) = 0;
                end
            end
        end
    end
    [intseq, fault_seq_nuc] = nuc2int4_new(seqi);
end

if (fault_seq_struct == 0 & fault_seq_nuc == 0 & fault_seq_numlines == 0 & fault_seq_emptyline == 0 &
fault_seq_energy==0)
    seq_no = seq_no + 1;
    seqs{seq_no} = intseq;
    anti_inds{seq_no} = anti_indi;
    bulges_nonsym{seq_no} = bulge_nonsymi;
    bulges_sym{seq_no} = bulge_symi;

```

```

endbulges{seq_no} = endbulgei;
pal_id(seq_no) = this_pal_id;
energy(seq_no) = this_energy;
counter = counter + 1;
all_pal_ids(counter) = this_pal_id;
else
    disp(['faulty seq on pal id ' num2str(this_pal_id)])
    if(fault_seq_energy)
        disp(['reason is that there was no energy']);
    elseif(fault_seq_emptyline)
        disp(['reason is that there was an empty line in zucker']);
    elseif(fault_seq_numlines)
        disp(['reason is that there were not 4 lines in the draw']);
    elseif(fault_seq_struct)
        disp(['reason is that draw was messed has nuc in pair and bulge at the same time']);
    elseif(fault_seq_nuc)
        disp(['reason is that there was an illegal letter in the seq']);
    end
    counter = counter + 1;
    all_pal_ids(counter) = this_pal_id;
end
end
return
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [seq, anti_ind, bulge1, bulge2, endbulge, fault_seq] = get_features(structure)
% get sequence as well as bulge structure
fault_seq = 0;
%upper half (5' side)
bulge_row = 1; % the row of bulge letters
bulge_row_opposite = 4;
uphalf = structure(1:2,:);
[j,k] = find(isletter(uphalf));
max_col = max(k);
tmpmat = zeros(2,max_col);
count = 0;
for col = 1: max_col
    fl = find(isletter(uphalf(:,col)));
    if (length(fl)>1);
        fault_seq = 1;
        seq=nan;anti_ind=nan;bulge1=nan;bulge2=nan;endbulge=nan;
        return;
    end;
    if ~isempty(fl)
        count = count + 1;
        seq(count) = uphalf(fl,col);
        bulge = (fl == bulge_row);
        if(bulge)
            tmpmat(1,col) = 0;
        else

```

```

        tmpmat(1,col) = count;
    end
    bulge1(count) = 0;
    bulge2(count) = 0;
    if bulge & isletter(structure(bulge_row_opposite,col))
        bulge2(count) = 1;
    elseif bulge & ~isletter(structure(bulge_row_opposite,col))
        bulge1(count) = 1;
    end
end
end
end
% endbulge is coded on the upper half
% go backwards from 3' side to 5' side
endbulge = zeros(size(bulge1));
lwhalf = structure(3:4,:);
pos = length(bulge1);
while bulge1(pos) == 1
    endbulge(pos) = 1;
    bulge1(pos) = 0;
    pos = pos - 1;
end
%lower half
bulge_row = 2; % 4 th line on structure is 2 line on lower half
bulge_row_opposite = 1;
[j,k] = find(isletter(lwhalf));
max_col = max(k);
for col = max_col:-1:1
    fl = find(isletter(lwhalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        seq(count) = lwhalf(fl,col);
        bulge = (fl == bulge_row);
        if(bulge)
            tmpmat(2,col) = 0;
        else
            tmpmat(2,col) = count;
        end
        bulge1(count) = 0;
        bulge2(count) = 0;
        if bulge & isletter(structure(bulge_row_opposite,col))
            bulge2(count) = 1;
        elseif bulge & ~isletter(structure(bulge_row_opposite,col))
            bulge1(count) = 1;
        end
        endbulge(count) = 0;
    end
end
anti_ind = zeros(size(bulge1));
for col=1:max_col
    if(tmpmat(1,col))

```

```

    anti_ind(tmpmat(1,col)) = tmpmat(2,col);
    anti_ind(tmpmat(2,col)) = tmpmat(1,col);
end
end
return
function [xp2,yp2] = plot_errors_bins2(pos_error,score,N)
% measure the distribution of erros
if length(pos_error) ~= length(score)
    error('pos_estimated and score not compatible');
end
if ~exist('N')
    N = 6;
end
perc = [1:-1/N:0]*100;
thresh = prctile(score, perc);
accuracy = zeros(0);
dist1 = zeros(0); %correct size, distance = 1;
dist2 = zeros(0);
dith = zeros(0);
fraction = zeros(0);
count = 0;
N = length(pos_error);
for i = 1:length(thresh)-1
    I = find(score <= thresh(i) & score >= thresh(i+1));
    if ~isempty(I)
        count = count + 1;
        midbin(count) = mean(score(I));

        accuracy(count) = sum(pos_error(I) == 0)/length(I);
        J1 = find(abs(pos_error(I)) == 1);
        dist1(count) = length(J1)/length(I);
        J2 = find(abs(pos_error(I)) == 2);
        dist2(count) = length(J2)/length(I);
        Jh = find(abs(pos_error(I)) > 2);
        dith(count) = length(Jh)/length(I);
        fraction(count) = length(I)/N;
    else
        count = count+1;
        midbin(count) = NaN;;
        accuracy(count) = NaN;
        dist1(count) = NaN;
        dist2(count) = NaN;
        dith(count) = NaN;
        fraction(count) = NaN;
    end
end
acc1 = accuracy + dist1;
acc2 = accuracy + dist1 + dist2;
hold on
plot(midbin, acc2,'g')

```

```

plot(midbin, acc1,'r')
plot(midbin, accuracy,'b')
plot(midbin,fraction,'c')
legend('dist \leq 2', 'dist \leq 1', 'precise',2);
plot(midbin, acc2,'*g')
plot(midbin, acc1,'or')
plot(midbin, accuracy,'bd')
xlabel('bin');
%axis([min(midbin)-1 max(midbin)+1 0 1])
[ry,yp2,mass,xp2,newy,pos] = isotonic_regression(midbin,acc2);
yp2(end)
returnfunction plot_errors_perc(pos_error,score)
% measure the distribution of erros
N = 100;
perc = [1:-1/N:0]*100;
thresh = prctile(score, perc);
accuracy = zeros(0);
dist1 = zeros(0); %correct size, distance = 1;
dist2 = zeros(0);
dith = zeros(0);
fraction = zeros(0);
count = 0;
N = length(pos_error);
for i = 1:length(thresh)
    I = find(score >= thresh(i));
    if ~isempty(I)
        count = count + 1;
        accuracy(count) = sum(pos_error(I) == 0)/length(I);
        J1 = find(abs(pos_error(I)) == 1);
        dist1(count) = length(J1)/length(I);
        J2 = find(abs(pos_error(I)) == 2);
        dist2(count) = length(J2)/length(I);
        Jh = find(abs(pos_error(I)) > 2);
        dith(count) = length(Jh)/length(I);
        fraction(count) = length(I)/N;
    else
        count = count+1;
        accuracy(count) = NaN;
        dist1(count) = NaN;
        dist2(count) = NaN;
        dith(count) = NaN;
        fraction(count) = NaN;
    end
end

acc1 = accuracy + dist1;
acc2 = accuracy + dist1 + dist2;
%clf
hold on

```

```

plot(perc, acc2,'g')
plot(perc, acc1,'r')
plot(perc, accuracy,'b')
plot(perc, thresh,'c')
legend('dist \leq 2', 'dist \leq 1', 'precise', 'threshold',2);
xlabel('percentage');
axis([0 100 0 1]);

%keyboard
%prepare result
N = length(accuracy);
res = [accuracy(N), acc1(N), acc2(N), acc2(round(0.2*N))]
returnfunction y = prctile(x,p);
%PRCTILE gives the percentiles of the sample in X.
% Y = PRCTILE(X,P) returns a value that is greater than P percent
% of the values in X. For example, if P = 50 Y is the median of X.
%
% P may be either a scalar or a vector. For scalar P, Y is a row
% vector containing Pth percentile of each column of X. For vector P,
% the ith row of Y is the P(i) percentile of each column of X.
% Copyright (c) 1993-98 by The MathWorks, Inc.
% $Revision: 2.6 $ $Date: 1997/11/29 01:46:27 $
[prows pcols] = size(p);
if prows ~= 1 & pcols ~= 1
    error('P must be a scalar or a vector.');
```

end

```

if any(p > 100) | any(p < 0)
    error('P must take values between 0 and 100');
```

end

```

xx = sort(x);
[m,n] = size(x);
if m==1 | n==1
    m = max(m,n);
    if m == 1,
        y = x*ones(length(p),1);
        return;
    end
    n = 1;
    q = 100*(0.5:m - 0.5)./m;
    xx = [min(x); xx(:); max(x)];
else
    q = 100*(0.5:m - 0.5)./m;
    xx = [min(x); xx; max(x)];
end
q = [0 q 100];
y = interp1(q,xx,p);
function [bps,len] = read_bp(filename);
%[bps,len] = read_bp(filename);
%reads bp file into cell array. bps{i} is a 3col matrix of the bp probs
%len(i) is the length of the ith palindrom (appears as info in the bp file)
```

```

fid = fopen(filename,'r');
if fid == -1
    error([' file ' filename ' could not be opened']);
end
seq_no = 0;
while ~feof(fid)
    pallen = str2num(fgetl(fid));
    arm5 = str2num(fgetl(fid));
    arm3 = str2num(fgetl(fid));
    p = str2num(fgetl(fid));
    seq_no = seq_no+1;
    bps{seq_no} = [arm5',arm3',p'];
    len(seq_no) = pallen;
end
fclose(fid);
return

```

```

function [seqs,len] = read_seq(filename);
%[seqs,len] = read_seq(filename);
%reads dicer or pal sequences into cell array, in numeric format
fid = fopen(filename,'r');
if fid == -1
    error([' file ' filename ' could not be opened']);
end
id = 0;
seq_no = 0;
while ~feof(fid)
    line = fgetl(fid);
    line = deblank(line);
    [intseq, fault_seq] = nuc2int4_new(line);
    id = id + 1;
    if fault_seq == 0
        seq_no = seq_no + 1;
        seqs{seq_no} = intseq;
        len(seq_no) = length(intseq);
    else
        disp(['faulty seq on id ' num2str(id)])
    end

    if(mod(seq_no,1000) == 0 & seq_no ~= 0)
        disp(['seq_no ' num2str(seq_no)]);
    end
end
fclose(fid);
return

```

```

function [seqs,len, ids,all_ids] = read_seq_with_id(filename);
%[seqs,len,ids,all_ids] = read_seq_id(filename);
%reads mirr or pal sequences into cell array, in numeric format
%the input file must contain for each seq 2 lines, first is id, second is the seq

```

% ids holds the ids of those that were read succesfully so has same length as seqs

% all\_ids is all ids encountered in the file regardless of whether were legal

```
fid = fopen(filename,'r');
```

```
if fid == -1
```

```
    error(['file ' filename ' could not be opened']);
```

```
end
```

```
id = 0;
```

```
seq_no = 0;
```

```
all_ids = [];
```

```
while ~feof(fid)
```

```
    this_id = str2num(fgetl(fid));
```

```
    all_ids = [all_ids,this_id];
```

```
    line = fgetl(fid);
```

```
    line = deblank(line);
```

```
    [intseq, fault_seq] = nuc2int4_new(line);
```

```
    if fault_seq == 0
```

```
        seq_no = seq_no + 1;
```

```
        seqs{seq_no} = intseq;
```

```
        len(seq_no) = length(intseq);
```

```
        ids(seq_no) = this_id;
```

```
    else
```

```
        disp(['faulty seq on id ' num2str(id)])
```

```
    end
```

```
if(mod(seq_no,1000) == 0 & seq_no ~= 0)
```

```
    disp(['seq_no ' num2str(seq_no)]);
```

```
end
```

```
end
```

```
fclose(fid);
```

```
return
```

```
function [mfes,anti_inds,bulges_nonsym,bulges_sym,endbulges,seq_id]= read_structure_from_mfe(filename);
```

```
% read rnafold structure
```

```
% seq is a cell array containing sequences (in ints)
```

```
% anti_inds holds for each nuc in the seq what is the index of the nuc across from it where the 0 means unpaired.
```

```
% bulge_nonsym is a cell array with binary strings with 1 for one sided bulge (not incl. end bulge)
```

```
% bulge_sym is similarly for 2 sided bulge
```

```
% note that any nuc ina bulge which has a bulge across gets bulge_sym even if it itself is across a -
```

```
% this is the difference from the original read_structure
```

```
% endbulge is a cell array with binary strings with 1 on the end bulge only
```

```
% the input file contains 3 lines for each paindrom. the first line is a single number indicating the pal length
```

```
% the second and third lines are the base pairs in the mfe structure
```

```
fid = fopen(filename,'r');
```

```
seq_no = 0;
```

```
mfe = cell(0);
```

```
bulges_nonsym= cell(0);
```

```
bulges_sym= cell(0);
```

```
endbulges = cell(0);
```

```
while ~feof(fid)
```

```

pallen = str2num(fgetl(fid));
arm5 = str2num(fgetl(fid));
arm3 = str2num(fgetl(fid));
seq_no = seq_no+1;

mfes{seq_no} = [arm5',arm3'];

ai = zeros(1,pallen);
ai(arm5) = arm3;
ai(arm3) = arm5;
anti_inds{seq_no} = ai;

ebs = zeros(1,pallen);
eb_start = arm5(end)+1;
eb_end = arm3(end)-1;
ebs(eb_start:eb_end) = 1;
endbulges{seq_no} = ebs;
if(eb_end-eb_start+1 < 3)
    disp(['end bulge shorter than 3 nucs in seq no ' num2str(seq_no)]);
end

bs = zeros(1,pallen);
bns = zeros(1,pallen);
arm5t = [0,arm5];
arm3t = [pallen+1,arm3];
for i=2:length(arm5t)
    d5 = arm5t(i)-arm5t(i-1)-1;
    d3 = arm3t(i-1)-arm3t(i)-1;
    if(d5)
        if(d3)
            bs([arm5t(i-1)+1:arm5t(i)-1 , arm3t(i)+1:arm3t(i-1)-1])=1;
        else
            bns(arm5t(i-1)+1:arm5t(i)-1) = 1;
        end
    else
        if(d3)
            bns(arm3t(i)+1:arm3t(i-1)-1) = 1;
        end
    end
end
bulges_sym{seq_no} = bs;
bulges_nonsym{seq_no} = bns;

end
seq_id = 1:seq_no;
fclose(fid);

function [seqs,bulges_nonsym,bulges_sym,endbulges,seq_id] = read_structure_new(filename);
% read zucker structure
% seq is a cell array containing sequences

```

```

% bulge_nonsym is a cell array with binary strings with 1 for one sided bulge (not incl. end bulge)
% bulge_sym is similarly for 2 sided bulge
% note that any nuc ina bulge which has a bulge across gets bulge_sym even if it itself is across a -
% this is the difference from the original read_structure
% endbulge is a cell array with binary strings with 1 on the end bulge only
Mxplen = 250; % maximal length of palindrom
fid = fopen(filename,'r');
seq_no = 0;
seqs = cell(0);
bulges_nonsym= cell(0);
bulges_sym= cell(0);
endbulges = cell(0);
seq_id = zeros(0);
id = 0;
while ~feof(fid)
    structure = char(4,250);
    for i = 1:4
        line = fgetl(fid);
        structure(i,1:length(line)) = line;
    end
    id = id +1;
    [seqi, bulge1i, bulge2i, endbulgei] = get_features(structure);
    % this is the old bulge1 and bulge2, now need to correct that
    bulge_nonsymi=bulge1i;
    bulge_symi=bulge2i;
    for j = 1:length(seqi)
        if(bulge_nonsymi(j))
            if(bulge_symi(max(1,j-1))) % a neighbor has a bulgesym flag on
                bulge_symi(j) = 1;
                bulge_nonsymi(j) = 0;
            end
        end
    end
end
for j = length(seqi):-1:1
    if(bulge_nonsymi(j))
        if(bulge_symi(min(j+1,length(seqi)))) % a neighbor has a bulgesym flag on
            bulge_symi(j) = 1;
            bulge_nonsymi(j) = 0;
        end
    end
end
end

[intseq, fault_seq] = nuc2int4_new(seqi);
if fault_seq == 0
    seq_no = seq_no + 1;
    seqs{seq_no} = intseq;
    bulges_nonsym{seq_no} = bulge_nonsymi;
    bulges_sym{seq_no} = bulge_symi;
    endbulges{seq_no} = endbulgei;
    seq_id(seq_no) = id;
end

```

```

else
    disp(['faulty seq on id ' num2str(id)])
end
if(mod(seq_no,1000) == 0)
    seq_no
end
end
fclose(fid);
return
function [seq, bulge1, bulge2, endbulge] = get_features(structure)
% get sequence as well as bulge structure
%upper half (5' side)
bulge_row = 1; % the row of bulge letters
bulge_row_opposite = 4;
uphalf = structure(1:2,:);
[j,k] = find(isletter(uphalf));
max_col = max(k);
count = 0;
for col =1: max_col
    fl = find(isletter(uphalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        seq(count) = uphalf(fl,col);
        bulge = (fl == bulge_row);
        bulge1(count) = 0;
        bulge2(count) = 0;
        if bulge & isletter(structure(bulge_row_opposite,col))
            bulge2(count) = 1;
        elseif bulge & ~isletter(structure(bulge_row_opposite,col))
            bulge1(count) = 1;
        end
    end
end
end
% endbulge is coded on the upper half
% go backwards from 3' side to 5' side
endbulge = zeros(size(bulge1));
pos = length(bulge1);
while bulge1(pos) == 1
    endbulge(pos) = 1;
    bulge1(pos) = 0;
    pos = pos - 1;
end
%lower half
bulge_row = 2; % 4 th line on structure is 2 line on lower half
bulge_row_opposite = 1;
lwhalf = structure(3:4,:);
[j,k] = find(isletter(lwhalf));
max_col = max(k);
for col =max_col:-1:1
    fl = find(isletter(lwhalf(:,col)));

```

```

if ~isempty(fl)
    count = count + 1;
    seq(count) = lwhalf(fl,col);
    bulge = (fl == bulge_row);
    bulge1(count) = 0;
    bulge2(count) = 0;
    if bulge & isletter(structure(bulge_row_opposite,col))
        bulge2(count) = 1;
    elseif bulge & ~isletter(structure(bulge_row_opposite,col))
        bulge1(count) = 1;
    end
    endbulge(count) = 0;
end
end
return

```

```

function [seqs,anti_inds,bulges_nonsym,bulges_sym,endbulges,pal_id,energy,all_pal_ids] =
read_structure_with_id_fid(fid,seqtot)
% function [seqs,anti_inds,bulges_nonsym,bulges_sym,endbulges,pal_id,energy,all_pal_ids] =
read_structure_with_id_fid(fid,seqtot)
% same as read_structure_withanti_fid but reads file that have before the 4 line zucker draw
% a line giving the pal_id and a line giving the energy.
% all_pal_ids is all ids read from file, whether faulty or not
% new feature: checks that draw is not messed up and if it is gives faulty seq.
Mxplen = 250; % maximal length of palindrom
counter = 0;
seq_no = 0;
seqs = cell(0);
bulges_nonsym= cell(0);
bulges_sym= cell(0);
endbulges = cell(0);
pal_id = zeros(0);
energy = zeros(0);
while ~feof(fid) & seq_no < seqtot
    this_pal_id = str2double(fgetl(fid));
    this_energy = str2double(fgetl(fid));
    structure = char(4,250);
    i = 0;
    line = fgetl(fid);
    if(isempty(line))
        line = 'emptyline';
        fault_seq_emptyline = 1;
    else
        fault_seq_emptyline = 0;
    end
    while(line(1)~= '|') % if emptyline this is always true so will go into loop
        i = i+1;
        structure(i,1:length(line)) = line;
        line = fgetl(fid);
        if(isempty(line))

```

```

        line = 'emptyline';
        fault_seq_emptyline = 1;
    end
end
if(i~=4)
    fault_seq_numlines = 1;
else
    fault_seq_numlines = 0;
end

fault_seq_struct = 1; % guilty until proven innocent
fault_seq_nuc = 1;
if(fault_seq_numlines == 0 & fault_seq_emptyline==0)
    [seqi, anti_indi, bulge1i, bulge2i, endbulgei,fault_seq_struct] = get_features(structure);
    if(fault_seq_struct==0)
        % this is the old bulge1 and bulge2, now need to correct that
        bulge_nonsymi=bulge1i;
        bulge_symi=bulge2i;
        for j = 1:length(seqi)
            if(bulge_nonsymi(j))
                if(bulge_symi(max(1,j-1))) % a neighbor has a bulgesym flag on
                    bulge_symi(j) = 1;
                    bulge_nonsymi(j) = 0;
                end
            end
        end
        for j = length(seqi):-1:1
            if(bulge_nonsymi(j))
                if(bulge_symi(min(j+1,length(seqi)))) % a neighbor has a bulgesym flag on
                    bulge_symi(j) = 1;
                    bulge_nonsymi(j) = 0;
                end
            end
        end
        [intseq, fault_seq_nuc] = nuc2int4_new(seqi);
    end
end

if (fault_seq_struct == 0 & fault_seq_nuc == 0 & fault_seq_numlines == 0 & fault_seq_emptyline == 0)
    seq_no = seq_no + 1;
    seqs{seq_no} = intseq;
    anti_inds{seq_no} = anti_indi;
    bulges_nonsym{seq_no} = bulge_nonsymi;
    bulges_sym{seq_no} = bulge_symi;
    endbulges{seq_no} = endbulgei;
    pal_id(seq_no) = this_pal_id;
    energy(seq_no) = this_energy;
    counter = counter + 1;
    all_pal_ids(counter) = this_pal_id;
else

```

```

disp(['faulty seq on pal id ' num2str(this_pal_id)])
if(fault_seq_emptyline)
    disp(['reason is that there was an empty line in zucker']);
elseif(fault_seq_numlines)
    disp(['reason is that there were not 4 lines in the draw']);
elseif(fault_seq_struct)
    disp(['reason is that draw was messed has nuc in pair and bulge at the same time']);
elseif(fault_seq_nuc)
    disp(['reason is that there was an illegal letter in the seq']);
end
counter = counter + 1;
all_pal_ids(counter) = this_pal_id;
end
end
return
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [seq, anti_ind, bulge1, bulge2, endbulge, fault_seq] = get_features(structure)
% get sequence as well as bulge structure
fault_seq = 0;
%upper half (5' side)
bulge_row = 1; % the row of bulge letters
bulge_row_opposite = 4;
uphalf = structure(1:2,:);
[j,k] = find(isletter(uphalf));
max_col = max(k);
tmpmat = zeros(2,max_col);
count = 0;
for col =1: max_col
    fl = find(isletter(uphalf(:,col)));
    if (length(fl)>1);
        fault_seq = 1;
        seq=nan;anti_ind=nan;bulge1=nan;bulge2=nan;endbulge=nan;
        return;
    end;
    if ~isempty(fl)
        count = count + 1;
        seq(count) = uphalf(fl,col);
        bulge = (fl == bulge_row);
        if(bulge)
            tmpmat(1,col) = 0;
        else
            tmpmat(1,col) = count;
        end
        bulge1(count) = 0;
        bulge2(count) = 0;
        if bulge & isletter(structure(bulge_row_opposite,col))
            bulge2(count) = 1;
        elseif bulge & ~isletter(structure(bulge_row_opposite,col))
            bulge1(count) = 1;
        end
    end
end

```

```

        end
    end
end
% endbulge is coded on the upper half
% go backwards from 3' side to 5' side
endbulge = zeros(size(bulge1));
lwhalf = structure(3:4,:);
pos = length(bulge1);
while bulge1(pos) == 1
    endbulge(pos) = 1;
    bulge1(pos) = 0;
    pos = pos - 1;
end
%lower half
bulge_row = 2; % 4 th line on structure is 2 line on lower half
bulge_row_opposite = 1;
[j,k] = find(isletter(lwhalf));
max_col = max(k);
for col = max_col:-1:1
    fl = find(isletter(lwhalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        seq(count) = lwhalf(fl,col);
        bulge = (fl == bulge_row);
        if(bulge)
            tmpmat(2,col) = 0;
        else
            tmpmat(2,col) = count;
        end
        bulge1(count) = 0;
        bulge2(count) = 0;
        if bulge & isletter(structure(bulge_row_opposite,col))
            bulge2(count) = 1;
        elseif bulge & ~isletter(structure(bulge_row_opposite,col))
            bulge1(count) = 1;
        end
        endbulge(count) = 0;
    end
end
end
anti_ind = zeros(size(bulge1));
for col=1:max_col
    if(tmpmat(1,col))
        anti_ind(tmpmat(1,col)) = tmpmat(2,col);
        anti_ind(tmpmat(2,col)) = tmpmat(1,col);
    end
end
return
function [seqs,anti_inds,bulges_nonsym,bulges_sym,endbulges,pal_id,energy,all_pal_ids] =
read_structure_with_id_fid_ce(fid,seqtot)
% function [seqs,anti_inds,bulges_nonsym,bulges_sym,endbulges,pal_id,energy,all_pal_ids] =
read_structure_with_id_fid_ce(fid,seqtot)

```

```

% same as read_structure_withanti_fid but reads file that have before the 4 line zucker draw
% a line giving the pal_id and a line giving the energy.
% all_pal_ids is all ids read from file, whether faulty or not
% new feature: checks that draw is not messed up and if it is gives faulty seq.
% in this check_e version returns faulty seq also when no energy found
Mxplen = 250; % maximal length of palindrom
counter = 0;
seq_no = 0;
seqs = cell(0);
bulges_nonsym= cell(0);
bulges_sym= cell(0);
endbulges = cell(0);
pal_id = zeros(0);
energy = zeros(0);
while ~feof(fid) & seq_no < seqtot
    this_pal_id = str2double(fgetl(fid));
    this_energy = str2double(fgetl(fid));
    if(isnan(this_energy))
        fault_seq_energy = 1;
    else
        fault_seq_energy = 0;
    end
    structure = char(4,250);
    i = 0;
    line = fgetl(fid);
    if isempty(line)
        line = 'emptyline';
        fault_seq_emptyline = 1;
    else
        fault_seq_emptyline = 0;
    end
    while(line(1)~= '|') % if emptyline this is always true so will go into loop
        i = i+1;
        structure(i,1:length(line)) = line;
        line = fgetl(fid);
        if isempty(line)
            line = 'emptyline';
            fault_seq_emptyline = 1;
        end
    end
end
if(i~=4)
    fault_seq_numlines = 1;
else
    fault_seq_numlines = 0;
end

fault_seq_struct = 1; % guilty until proven innocent
fault_seq_nuc = 1;
if(fault_seq_numlines == 0 & fault_seq_emptyline==0 & fault_seq_energy==0)
    [seqi, anti_indi, bulge1i, bulge2i, endbulgei,fault_seq_struct] = get_features(structure);

```

```

if(fault_seq_struct==0)
    % this is the old bulge1 and bulge2, now need to correct that
    bulge_nonsymi=bulge1i;
    bulge_symi=bulge2i;
    for j = 1:length(seqi)
        if(bulge_nonsymi(j))
            if(bulge_symi(max(1,j-1))) % a neighbor has a bulgesym flag on
                bulge_symi(j) = 1;
                bulge_nonsymi(j) = 0;
            end
        end
    end
    for j = length(seqi):-1:1
        if(bulge_nonsymi(j))
            if(bulge_symi(min(j+1,length(seqi)))) % a neighbor has a bulgesym flag on
                bulge_symi(j) = 1;
                bulge_nonsymi(j) = 0;
            end
        end
    end
    [intseq, fault_seq_nuc] = nuc2int4_new(seqi);
end
end

if (fault_seq_struct == 0 & fault_seq_nuc == 0 & fault_seq_numlines == 0 & fault_seq_emptyline == 0 &
fault_seq_energy==0)
    seq_no = seq_no + 1;
    seqs{seq_no} = intseq;
    anti_inds{seq_no} = anti_indi;
    bulges_nonsym{seq_no} = bulge_nonsymi;
    bulges_sym{seq_no} = bulge_symi;
    endbulges{seq_no} = endbulgei;
    pal_id(seq_no) = this_pal_id;
    energy(seq_no) = this_energy;
    counter = counter + 1;
    all_pal_ids(counter) = this_pal_id;
else
    disp(['faulty seq on pal id ' num2str(this_pal_id)])
    if(fault_seq_energy)
        disp(['reason is that there was no energy']);
    elseif(fault_seq_emptyline)
        disp(['reason is that there was an empty line in zuker']);
    elseif(fault_seq_numlines)
        disp(['reason is that there were not 4 lines in the draw']);
    elseif(fault_seq_struct)
        disp(['reason is that draw was messed has nuc in pair and bulge at the same time']);
    elseif(fault_seq_nuc)
        disp(['reason is that there was an illegal letter in the seq']);
    end
    counter = counter + 1;
end

```

```

    all_pal_ids(counter) = this_pal_id;
end
end
return
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [seq, anti_ind, bulge1, bulge2, endbulge, fault_seq] = get_features(structure)
% get sequence as well as bulge structure
fault_seq = 0;
%upper half (5' side)
bulge_row = 1; % the row of bulge letters
bulge_row_opposite = 4;
uphalf = structure(1:2,:);
[j,k] = find(isletter(uphalf));
max_col = max(k);
tmpmat = zeros(2,max_col);
count = 0;
for col = 1: max_col
    fl = find(isletter(uphalf(:,col)));
    if (length(fl)>1);
        fault_seq = 1;
        seq=nan;anti_ind=nan;bulge1=nan;bulge2=nan;endbulge=nan;
        return;
    end;
    if ~isempty(fl)
        count = count + 1;
        seq(count) = uphalf(fl,col);
        bulge = (fl == bulge_row);
        if(bulge)
            tmpmat(1,col) = 0;
        else
            tmpmat(1,col) = count;
        end
        bulge1(count) = 0;
        bulge2(count) = 0;
        if bulge & isletter(structure(bulge_row_opposite,col))
            bulge2(count) = 1;
        elseif bulge & ~isletter(structure(bulge_row_opposite,col))
            bulge1(count) = 1;
        end
    end
end
end
% endbulge is coded on the upper half
% go backwards from 3' side to 5' side
endbulge = zeros(size(bulge1));
lwhalf = structure(3:4,:);
pos = length(bulge1);
while bulge1(pos) == 1
    endbulge(pos) = 1;
    bulge1(pos) = 0;
end

```

```

    pos = pos - 1;
end
%lower half
bulge_row = 2; % 4 th line on structure is 2 line on lower half
bulge_row_opposite = 1;
[j,k] = find(isletter(lwhalf));
max_col = max(k);
for col = max_col:-1:1
    fl = find(isletter(lwhalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        seq(count) = lwhalf(fl,col);
        bulge = (fl == bulge_row);
        if(bulge)
            tmpmat(2,col) = 0;
        else
            tmpmat(2,col) = count;
        end
        bulge1(count) = 0;
        bulge2(count) = 0;
        if bulge & isletter(structure(bulge_row_opposite,col))
            bulge2(count) = 1;
        elseif bulge & ~isletter(structure(bulge_row_opposite,col))
            bulge1(count) = 1;
        end
        endbulge(count) = 0;
    end
end
anti_ind = zeros(size(bulge1));
for col=1:max_col
    if(tmpmat(1,col))
        anti_ind(tmpmat(1,col)) = tmpmat(2,col);
        anti_ind(tmpmat(2,col)) = tmpmat(1,col);
    end
end
return
function [seqs,anti_inds,bulges_nonsym,bulges_sym,endbulges,pal_id,energy,all_pal_ids] =
read_structure_with_id_fid(fid,seqtot)
% function [seqs,anti_inds,bulges_nonsym,bulges_sym,endbulges,pal_id,energy,all_pal_ids] =
read_structure_with_id_fid(fid,seqtot)
% same as read_structure_withanti_fid but reads file that have before the 4 line zucker draw
% a line giving the pal_id and a line giving the energy.
% all_pal_ids is all ids read from file, whether faulty or not
Mxplen = 250; % maximal length of palindrom
counter = 0;
seq_no = 0;
seqs = cell(0);
bulges_nonsym= cell(0);
bulges_sym= cell(0);
endbulges = cell(0);

```

```

pal_id = zeros(0);
energy = zeros(0);
while ~feof(fid) & seq_no < seqtot
    this_pal_id = str2num(fgetl(fid));
    this_energy = str2num(fgetl(fid));
    structure = char(4,250);
    for i = 1:4
        line = fgetl(fid);
        structure(i,1:length(line)) = line;
    end
    [seqi, anti_indi, bulge1i, bulge2i, endbulgei] = get_features(structure);
    % this is the old bulge1 and bulge2, now need to correct that
    bulge_nonsymi=bulge1i;
    bulge_symi=bulge2i;
    for j = 1:length(seqi)
        if(bulge_nonsymi(j))
            if(bulge_symi(max(1,j-1))) % a neighbor has a bulgesym flag on
                bulge_symi(j) = 1;
                bulge_nonsymi(j) = 0;
            end
        end
    end
end
for j = length(seqi):-1:1
    if(bulge_nonsymi(j))
        if(bulge_symi(min(j+1,length(seqi)))) % a neighbor has a bulgesym flag on
            bulge_symi(j) = 1;
            bulge_nonsymi(j) = 0;
        end
    end
end
end

[intseq, fault_seq] = nuc2int4_new(seqi);
if fault_seq == 0
    seq_no = seq_no + 1;
    seqs{seq_no} = intseq;
    anti_inds{seq_no} = anti_indi;
    bulges_nonsym{seq_no} = bulge_nonsymi;
    bulges_sym{seq_no} = bulge_symi;
    endbulges{seq_no} = endbulgei;
    pal_id(seq_no) = this_pal_id;
    energy(seq_no) = this_energy;
    counter = counter + 1;
    all_pal_ids(counter) = this_pal_id;
else
    disp(['faulty seq on pal id ' num2str(this_pal_id)])
    counter = counter + 1;
    all_pal_ids(counter) = this_pal_id;
end
end
return

```

```

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [seq, anti_ind, bulge1, bulge2, endbulge] = get_features(structure)
% get sequence as well as bulge structure
%upper half (5' side)
bulge_row = 1; % the row of bulge letters
bulge_row_opposite = 4;
uphalf = structure(1:2,:);
[j,k] = find(isletter(uphalf));
max_col = max(k);
tmpmat = zeros(2,max_col);
count = 0;
for col =1: max_col
    fl = find(isletter(uphalf(:,col)));
    if (length(fl)>1); keyboard;end;
    if ~isempty(fl)
        count = count + 1;
        seq(count) = uphalf(fl,col);
        bulge = (fl == bulge_row);
        if(bulge)
            tmpmat(1,col) = 0;
        else
            tmpmat(1,col) = count;
        end
        bulge1(count) = 0;
        bulge2(count) = 0;
        if bulge & isletter(structure(bulge_row_opposite,col))
            bulge2(count) = 1;
        elseif bulge & ~isletter(structure(bulge_row_opposite,col))
            bulge1(count) = 1;
        end
    end
end
end
% endbulge is coded on the upper half
% go backwards form 3' side to 5' side
endbulge = zeros(size(bulge1));
lwhalf = structure(3:4,:);
pos = length(bulge1);
while bulge1(pos) == 1
    endbulge(pos) = 1;
    bulge1(pos) = 0;
    pos = pos - 1;
end
%lower half
bulge_row = 2; % 4 th line on structure is 2 line on lower half
bulge_row_opposite = 1;
[j,k] = find(isletter(lwhalf));
max_col = max(k);
for col =max_col:-1:1
    fl = find(isletter(lwhalf(:,col)));

```

```

if ~isempty(fl)
    count = count + 1;
    seq(count) = lwhalf(fl,col);
    bulge = (fl == bulge_row);
    if(bulge)
        tmpmat(2,col) = 0;
    else
        tmpmat(2,col) = count;
    end
    bulge1(count) = 0;
    bulge2(count) = 0;
    if bulge & isletter(structure(bulge_row_opposite,col))
        bulge2(count) = 1;
    elseif bulge & ~isletter(structure(bulge_row_opposite,col))
        bulge1(count) = 1;
    end
    endbulge(count) = 0;
end
end
anti_ind = zeros(size(bulge1));
for col=1:max_col
    if(tmpmat(1,col))
        anti_ind(tmpmat(1,col)) = tmpmat(2,col);
        anti_ind(tmpmat(2,col)) = tmpmat(1,col);
    end
end
return
function [seqs,anti_inds,bulges_nonsym,bulges_sym,endbulges,seq_id] = read_structure_withanti(filename);
% read zucker structure
% seq is a cell array containing sequences (in ints)
% anti_inds holds for each nuc in the seq what is the index of the nuc across from it where the 0 means unpaired.
% bulge_nonsym is a cell array with binary strings with 1 for one sided bulge (not incl. end bulge)
% bulge_sym is similarly for 2 sided bulge
% note that any nuc in a bulge which has a bulge across gets bulge_sym even if it itself is across a -
% this is the difference from the original read_structure
% endbulge is a cell array with binary strings with 1 on the end bulge only
Mxplen = 250; % maximal length of palindrom
fid = fopen(filename,'r');
seq_no = 0;
seqs = cell(0);
bulges_nonsym= cell(0);
bulges_sym= cell(0);
endbulges = cell(0);
seq_id = zeros(0);
id = 0;
while ~feof(fid)
    structure = char(4,250);
    for i = 1:4
        line = fgetl(fid);
        structure(i,1:length(line)) = line;
    end
end

```

```

end
id = id + 1;
[seqi, anti_indi, bulge1i, bulge2i, endbulgei] = get_features(structure);
% this is the old bulge1 and bulge2, now need to correct that
bulge_nonsymi=bulge1i;
bulge_symi=bulge2i;
for j = 1:length(seqi)
    if(bulge_nonsymi(j))
        if(bulge_symi(max(1,j-1))) % a neighbor has a bulgesym flag on
            bulge_symi(j) = 1;
            bulge_nonsymi(j) = 0;
        end
    end
end
for j = length(seqi):-1:1
    if(bulge_nonsymi(j))
        if(bulge_symi(min(j+1,length(seqi)))) % a neighbor has a bulgesym flag on
            bulge_symi(j) = 1;
            bulge_nonsymi(j) = 0;
        end
    end
end

[intseq, fault_seq] = nuc2int4_new(seqi);
if fault_seq == 0
    seq_no = seq_no + 1;
    seqs{seq_no} = intseq;
    anti_inds{seq_no} = anti_indi;
    bulges_nonsym{seq_no} = bulge_nonsymi;
    bulges_sym{seq_no} = bulge_symi;
    endbulges{seq_no} = endbulgei;
    seq_id(seq_no) = id;
else
    disp(['faulty seq on id ' num2str(id)])
end
if(mod(seq_no,1000) == 0)
    seq_no
end
fclose(fid);
return
function [seq, anti_ind, bulge1, bulge2, endbulge] = get_features(structure)
% get sequence as well as bulge structure
%upper half (5' side)
bulge_row = 1; % the row of bulge letters
bulge_row_opposite = 4;
uphalf = structure(1:2,:);
[j,k] = find(isletter(uphalf));
max_col = max(k);
tmpmat = zeros(2,max_col);

```

```

count = 0;
for col =1: max_col
    fl = find(isletter(uphalf(:,col)));
    if (length(fl)>1); keyboard;end;
    if ~isempty(fl)
        count = count + 1;
        seq(count) = uphalf(fl,col);
        bulge = (fl == bulge_row);
        if(bulge)
            tmpmat(1,col) = 0;
        else
            tmpmat(1,col) = count;
        end
        bulge1(count) = 0;
        bulge2(count) = 0;
        if bulge & isletter(structure(bulge_row_opposite,col))
            bulge2(count) = 1;
        elseif bulge & ~isletter(structure(bulge_row_opposite,col))
            bulge1(count) = 1;
        end
    end
end
end
% endbulge is coded on the upper half
% go backwards form 3' side to 5' side
endbulge = zeros(size(bulge1));
lwhalf = structure(3:4,:);
pos = length(bulge1);
while bulge1(pos) == 1
    endbulge(pos) = 1;
    bulge1(pos) = 0;
    pos = pos - 1;
end
%lower half
bulge_row = 2; % 4 th line on structure is 2 line on lower half
bulge_row_opposite = 1;
[j,k] = find(isletter(lwhalf));
max_col = max(k);
for col =max_col:-1:1
    fl = find(isletter(lwhalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        seq(count) = lwhalf(fl,col);
        bulge = (fl == bulge_row);
        if(bulge)
            tmpmat(2,col) = 0;
        else
            tmpmat(2,col) = count;
        end
        bulge1(count) = 0;
        bulge2(count) = 0;
    end
end

```

```

    if bulge & isletter(structure(bulge_row_opposite,col))
        bulge2(count) = 1;
    elseif bulge & ~isletter(structure(bulge_row_opposite,col))
        bulge1(count) = 1;
    end
    endbulge(count) = 0;
end
end
anti_ind = zeros(size(bulge1));
for col=1:max_col
    if(tmpmat(1,col))
        anti_ind(tmpmat(1,col)) = tmpmat(2,col);
        anti_ind(tmpmat(2,col)) = tmpmat(1,col);
    end
end
end

return

```

```

function [seqs,anti_inds,bulges_nonsym,bulges_sym,endbulges,seq_id] = read_structure_withanti_fid(fid,seqtot);
%[seqs,anti_inds,bulges_nonsym,bulges_sym,endbulges,seq_id] = read_structure_withanti_fid(fid,seqtot);
% read zucker structure
% seq is a cell array containing sequences (in ints)
% anti_inds holds for each nuc in the seq what is the index of the nuc across from it where the 0 means unpaired.
% bulge_nonsym is a cell array with binary strings with 1 for one sided bulge (not incl. end bulge)
% bulge_sym is similarly for 2 sided bulge
% note that any nuc in a bulge which has a bulge across gets bulge_sym even if it itself is across a -
% this is the difference from the original read_structure
% endbulge is a cell array with binary strings with 1 on the end bulge only
Mxplen = 250; % maximal length of palindrom
seq_no = 0;
seqs = cell(0);
bulges_nonsym= cell(0);
bulges_sym= cell(0);
endbulges = cell(0);
seq_id = zeros(0);
id = 0;
while ~feof(fid) & seq_no < seqtot
    structure = char(4,250);
    for i = 1:4
        line = fgetl(fid);
        structure(i,1:length(line)) = line;
    end
    id = id +1;
    [seqi, anti_indi, bulge1i, bulge2i, endbulgei] = get_features(structure);
    % this is the old bulge1 and bulge2, now need to correct that
    bulge_nonsymi=bulge1i;
    bulge_symi=bulge2i;
    for j = 1:length(seqi)
        if(bulge_nonsymi(j))
            if(bulge_symi(max(1,j-1))) % a neighbor has a bulgesym flag on

```

```

        bulge_symi(j) = 1;
        bulge_nonsymi(j) = 0;
    end
end
end
for j = length(seqi):-1:1
    if(bulge_nonsymi(j))
        if(bulge_symi(min(j+1,length(seqi)))) % a neighbor has a bulgesym flag on
            bulge_symi(j) = 1;
            bulge_nonsymi(j) = 0;
        end
    end
end
end

[intseq, fault_seq] = nuc2int4_new(seqi);
if fault_seq == 0
    seq_no = seq_no + 1;
    seqs{seq_no} = intseq;
    anti_inds{seq_no} = anti_indi;
    bulges_nonsym{seq_no} = bulge_nonsymi;
    bulges_sym{seq_no} = bulge_symi;
    endbulges{seq_no} = endbulgei;
    seq_id(seq_no) = id;
else
    disp(['faulty seq on id ' num2str(id)])
end
end
return
function [seq, anti_ind, bulge1, bulge2, endbulge] = get_features(structure)
% get sequence as well as bulge structure
%upper half (5' side)
bulge_row = 1; % the row of bulge letters
bulge_row_opposite = 4;
uphalf = structure(1:2,:);
[j,k] = find(isletter(uphalf));
max_col = max(k);
tmpmat = zeros(2,max_col);
count = 0;
for col =1: max_col
    fl = find(isletter(uphalf(:,col)));
    if (length(fl)>1); keyboard;end;
    if ~isempty(fl)
        count = count + 1;
        seq(count) = uphalf(fl,col);
        bulge = (fl == bulge_row);
        if(bulge)
            tmpmat(1,col) = 0;
        else
            tmpmat(1,col) = count;
        end
    end
end

```

```

    bulge1(count) = 0;
    bulge2(count) = 0;
    if bulge & isletter(structure(bulge_row_opposite,col))
        bulge2(count) = 1;
    elseif bulge & ~isletter(structure(bulge_row_opposite,col))
        bulge1(count) = 1;
    end
end
end
% endbulge is coded on the upper half
% go backwards form 3' side to 5' side
endbulge = zeros(size(bulge1));
lwhalf = structure(3:4,:);
pos = length(bulge1);
while bulge1(pos) == 1
    endbulge(pos) = 1;
    bulge1(pos) = 0;
    pos = pos - 1;
end
%lower half
bulge_row = 2; % 4 th line on structure is 2 line on lower half
bulge_row_opposite = 1;
[j,k] = find(isletter(lwhalf));
max_col = max(k);
for col = max_col:-1:1
    fl = find(isletter(lwhalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        seq(count) = lwhalf(fl,col);
        bulge = (fl == bulge_row);
        if(bulge)
            tmpmat(2,col) = 0;
        else
            tmpmat(2,col) = count;
        end
        bulge1(count) = 0;
        bulge2(count) = 0;
        if bulge & isletter(structure(bulge_row_opposite,col))
            bulge2(count) = 1;
        elseif bulge & ~isletter(structure(bulge_row_opposite,col))
            bulge1(count) = 1;
        end
        endbulge(count) = 0;
    end
end
anti_ind = zeros(size(bulge1));
for col=1:max_col
    if(tmpmat(1,col))
        anti_ind(tmpmat(1,col)) = tmpmat(2,col);
        anti_ind(tmpmat(2,col)) = tmpmat(1,col);
    end
end

```

```

end
end

```

```

return

```

```

function y = stdnan(x)
if(min(size(x))==1)
    y = std(x(~isnan(x)));
    return;
end

```

```

y = zeros(1,size(x,2));
for i=1:size(x,2)
    v = x(:,i);
    y(i) = std(v(~isnan(v)));
end

```

```

function [sym_in_win, sym_out, faulty] = symm(pal_len,mfe,winstart5,win_len)
% function [sym_in_win, sym_out, faulty] = symm(pal_len, mfe,winstart5,win_len)
% if window is illegal, returns faulty=1 and NAN for other values
% pal_len is length of palindrom
% mfe has the pairs in the min free energy drawing
% winstart5 is the positon of the start of the window in question
% win_len is its length
% sym_in_win = number of unpaired bases in win - number in antiwin, normalized by their sum
% if win start/ends within a bulge takes in anti a proportional number of bases
% sym_out is number of unpaired on window arm - opposite arm - sym_in_win, normalized by
% total number of unpaired in both arms - those unpaired in win
% NOTE that both have a sign defined by the arm onwhich the window sits.
% also note that no check is made on winstart5 and win_len being positive (which they must) - beware!

```

```

arm5 = mfe(:,1);
arm3 = mfe(:,2);
eb_start = arm5(end)+1;
eb_end = arm3(end)-1;
eb_len = eb_end-eb_start+1; % num nucs in end bulge
win_end = winstart5+win_len-1;
win_inds = [winstart5:win_end];
if(any(intersect(win_inds,[eb_start:eb_end])) | win_end>pal_len)
    faulty =1;
    sym_in_win = NaN;
    sym_out = NaN;
    disp('WINDOW IS ILLEGAL. RETURNING FAULTY=1. ');
    disp(['window has ' num2str(length(intersect(win_inds,[eb_start:eb_end]))) ' nucs in endloop']);
    return
end

```

```

faulty = 0;
m5 = diff(arm5)-1;
m3 = -1*diff(arm3)-1;
d53 = m5-m3;
if(winstart5<eb_start)
    win_arm5 = 1; % win on arm5
end

```

```

else
    win_arm5 = 0;
end
% create the vector bulges from the mfe structure!
bulges = ones(1,pal_len);
bulges(arm5) = 0;
bulges(arm3) = 0;
bulged5 = sum(bulges(1:eb_start-1));
bulged3 = sum(bulges(eb_end+1:end));
bulges_win = bulges(win_inds);
inwin = sum(bulges_win);
% sum antiwin without bulges
if(win_arm5)
    tt=find(arm5-winstart5 >= 0);
    ind1=tt(1); % index in arm5 of first base in win that is paired
    antiend = arm3(ind1);
    tt=find(arm5-win_end <= 0);
    ind2=tt(end); % as ind1 but last
    antistart = arm3(ind2);
    inantiwin = sum(bulges(antistart:antiend)); % without bulges at ends of anti
    if(bulges_win(1))
        if(ind1>1)
            partonwin = (arm5(ind1)-winstart5)/(arm5(ind1)-arm5(ind1-1)-1);
            inantiwin = inantiwin + (arm3(ind1-1)-arm3(ind1)-1)*partonwin;
        else
            partonwin = (arm5(ind1)-winstart5)/(arm5(ind1)-1);
            inantiwin = inantiwin + (length(bulges)-arm3(ind1))*partonwin;
        end
    end
end
if(bulges_win(end))
    partonwin = (win_end-arm5(ind2))/(arm5(ind2+1)-arm5(ind2)-1);
    inantiwin = inantiwin + (arm3(ind2)-arm3(ind2+1)-1)*partonwin;
end
dd = inwin-inantiwin;
sdd = inwin+inantiwin;
if(sdd)
    sym_in_win = dd / sdd;
else % dd must also be 0
    sym_in_win = 0;
end
if(bulged5+bulged3-sdd)
    sym_out = (bulged5-bulged3-dd) / (bulged5+bulged3-sdd);
else
    sym_out = 0;
end
else
    tt=find(arm3-winstart5 >= 0);
    ind1=tt(end); % index in arm3 of first base in win that is paired
    antiend = arm5(ind1);
    tt=find(arm3-win_end <= 0);

```

```

ind2=tt(1); % index in arm3 of last base in win that is paired
antistart = arm5(ind2);
inantiwin = sum(bulges(antistart:antiend)); % without bulges at ends of anti
if(bulges_win(1))
    partonwin = (arm3(ind1)-winstart5)/(arm3(ind1)-arm3(ind1+1)-1);
    inantiwin = inantiwin + (arm5(ind1+1)-arm5(ind1)-1)*partonwin;
end
if(bulges_win(end))
    if(ind2>1)
        partonwin = (win_end-arm3(ind2))/(arm3(ind2-1)-arm3(ind2)-1);
        inantiwin = inantiwin + (arm5(ind2)-arm5(ind2-1)-1)*partonwin;
    else
        partonwin = (win_end-arm3(ind2))/(length(bulges)-arm3(ind2));
        inantiwin = inantiwin + (arm5(ind2)-1)*partonwin;
    end
end
dd = inwin-inantiwin;
sdd = inwin+inantiwin;
if(sdd)
    sym_in_win = dd / sdd;
else % dd must also be 0
    sym_in_win = 0;
end
if(bulged3+bulged5-sdd)
    sym_out = (bulged3-bulged5-dd) / (bulged3+bulged5-sdd);
else
    sym_out = 0;
end
end
function [sym_in_win, sym_out, faulty] = symm2(pal_len,mfe,winstart5,win_len)
% function [sym_in_win, sym_out, faulty] = symm2(pal_len, mfe,winstart5,win_len)
% like symm but no normalization
arm5 = mfe(:,1);
arm3 = mfe(:,2);
eb_start = arm5(end)+1;
eb_end = arm3(end)-1;
eb_len = eb_end-eb_start+1; % num nucs in end bulge
win_end = winstart5+win_len-1;
win_inds = [winstart5:win_end];
if(any(intersect(win_inds,[eb_start:eb_end])) | win_end>pal_len)
    faulty =1;
    sym_in_win = NaN;
    sym_out = NaN;
    disp('WINDOW IS ILLEGAL. RETURNING FAULTY=1. ');
    disp(['window has ' num2str(length(intersect(win_inds,[eb_start:eb_end]))) ' nucs in endloop']);
    return
end
faulty = 0;
win_arm5 =(winstart5<eb_start);
% create the vector bulges from the mfe structure!

```

```

bulges = ones(1,pal_len);
bulges(arm5) = 0;
bulges(arm3) = 0;
bulges(eb_start:eb_end) = 0;
bulged5 = sum(bulges(1:eb_start-1));
bulged3 = sum(bulges(eb_end+1:end));
bulges_win = bulges(win_inds);
inwin = sum(bulges_win);
% sum antiwin without bulges
if(win_arm5)
    tt=find(arm5-winstart5 >= 0);
    ind1=tt(1); % index in arm5 of first base in win that is paired
    antiend = arm3(ind1);
    tt=find(arm5-win_end <= 0);
    ind2=tt(end); % as ind1 but last
    antistart = arm3(ind2);
    inantiwin = sum(bulges(antistart:antiend)); % without bulges at ends of anti
    if(bulges_win(1))
        if(ind1>1)
            partonwin = (arm5(ind1)-winstart5)/(arm5(ind1)-arm5(ind1-1)-1);
            inantiwin = inantiwin + (arm3(ind1-1)-arm3(ind1)-1)*partonwin;
        else
            partonwin = (arm5(ind1)-winstart5)/(arm5(ind1)-1);
            inantiwin = inantiwin + (length(bulges)-arm3(ind1))*partonwin;
        end
    end
    if(bulges_win(end))
        partonwin = (win_end-arm5(ind2))/(arm5(ind2+1)-arm5(ind2)-1);
        inantiwin = inantiwin + (arm3(ind2)-arm3(ind2+1)-1)*partonwin;
    end
    sym_in_win = inwin-inantiwin;
    sym_out = bulged5-bulged3-sym_in_win;
else
    tt=find(arm3-winstart5 >= 0);
    ind1=tt(end); % index in arm3 of first base in win that is paired
    antiend = arm5(ind1);
    tt=find(arm3-win_end <= 0);
    ind2=tt(1); % index in arm3 of last base in win that is paired
    antistart = arm5(ind2);
    inantiwin = sum(bulges(antistart:antiend)); % without bulges at ends of anti
    if(bulges_win(1))
        partonwin = (arm3(ind1)-winstart5)/(arm3(ind1)-arm3(ind1+1)-1);
        inantiwin = inantiwin + (arm5(ind1+1)-arm5(ind1)-1)*partonwin;
    end
    if(bulges_win(end))
        if(ind2>1)
            partonwin = (win_end-arm3(ind2))/(arm3(ind2-1)-arm3(ind2)-1);
            inantiwin = inantiwin + (arm5(ind2)-arm5(ind2-1)-1)*partonwin;
        else
            partonwin = (win_end-arm3(ind2))/(length(bulges)-arm3(ind2));

```

```

        inantiwin = inantiwin + (arm5(ind2)-1)*partonwin;
    end
end

sym_in_win = inwin-inantiwin;
sym_out = bulged3-bulged5-sym_in_win;
end
function seqs = transform_format(seqs,format);
%seqs = transform_format(seqs,format);
% format is either 'int' or 'nuc'
%if format not given, toggle format from int<-> nuc
% note that assume all seqs are in same format initially
if(nargin==1)
    if all(isletter(seqs{1}))
        format = 'int';
    else
        format = 'nuc';
    end
end
end

if(strcmp(format,'nuc'))
    for i = 1:length(seqs)
        seqs{i} = int2nuc(seqs{i});
    end
elseif(strcmp(format,'int'))
    for i = 1:length(seqs)
        seqs{i} = nuc2int(seqs{i});
    end
else
    error('transform_format: format (if given) must be int or nuc');
end
return

function visualize_dicer_structure(seqd, filename)
%visualize_dicer_structure(seqd, filename)
% show dicer on zuker structure
%seqd is in int
Mxplen = 250; % maximal length of palindrom
fid = fopen(filename,'r');
seq_no = 0;
seqs = cell(0);
while ~feof(fid)
    seq_no = seq_no + 1
    structure = char(4,250);
    for i = 1:4
        line = fgetl(fid);
        structure(i,1:length(line)) = line;
    end
    [seq1, bulge1, endbulge1] = get_features(structure);
    seqs{seq_no} = seq1;
end

```

```

pos = findstr(seqd{seq_no}, seq1)
if ~isempty(pos)
    lend = length(seqd{seq_no});
    % search on structure for pos
    [id,jd] = dicer_on_structure(pos, lend, structure);
else
    id = [];
    jd = [];
end

plot_structure(structure,id,jd);
pause

end
return
function [id,jd] = dicer_on_structure(pos, lend, structure)
uphalf = structure(1:2,:);
[j,k] = find(isletter(uphalf));
max_col = max(k);
count = 0;
dicercount = 0;
for col =1: max_col
    fl = find(isletter(uphalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        if count >=pos & count < pos + lend
            dicercount = dicercount+1;
            id(dicercount) = fl(1);
            jd(dicercount) = col;
        end
    end
end
end
lwhalf = structure(3:4,:);
[j,k] = find(isletter(lwhalf));
max_col = max(k);
for col =max_col:-1:1
    fl = find(isletter(lwhalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        if count >=pos & count < pos + lend
            dicercount = dicercount+1;
            id(dicercount) = fl(1) + 2;
            jd(dicercount) = col;
        end
    end
end
end
return
function plot_structure(structure,id,jd);
yscale = 1.5;
clf

```

```

hold on
axis equal
[j,k] = find(isletter(structure));
max_col = max(k);
axis([ 0 max(75,max_col) 0 5*yscale]);
for x = 1:max_col
    for y = 1:4
        text(x,yscale*y,structure(5-y,x)); % so upper appears on top
    end
end
for k = 1:length(id);
    H = text(jd(k),yscale*(5-id(k)),structure(id(k),jd(k)));
    set(H,'color',[1 0 0]);
end
return
function [seq, bulge, endbulge] = get_features(structure)
% get sequence as well as bulge structure
%upper half (5' side)
bulge_row = 1; % the row of bulge letters
uphalf = structure(1:2,:);
[j,k] = find(isletter(uphalf));
max_col = max(k);
count = 0;
for col =1: max_col
    fl = find(isletter(uphalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        seq(count) = uphalf(fl,col);
        bulge(count) = (fl == bulge_row);
    end
end
% endbulge is coded on the upper half
% go backwards from 3' side to 5' side
endbulge = zeros(size(bulge));
pos = length(bulge);
while bulge(pos) == 1
    endbulge(pos) = 1;
    pos = pos - 1;
end
%lower half
bulge_row = 2; % 4 th line on structure is 2 line on lower half
lwhalf = structure(3:4,:);
[j,k] = find(isletter(lwhalf));
max_col = max(k);
for col =max_col:-1:1
    fl = find(isletter(lwhalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        seq(count) = lwhalf(fl,col);
        bulge(count) = (fl == bulge_row);
    end
end

```

```

        endbulge(count) = 0;
    end
end
return

function visualize_dicer_structure_gidi(seqd, filename)
%visualize_dicer_structure(seqd, filename)
% show dicer on zucker structure
if(~exist('filename'))
    filename = 'c:\rosetta\data_baseline_13_4\zucker_draw_h121.txt';
end
Mxplen = 250; % maximal length of palindrom
fid = fopen(filename,'r');
seq_no = 0;
seqs = cell(0);
while ~feof(fid)
    seq_no = seq_no + 1
    structure = char(4,250);
    for i = 1:4
        line = fgetl(fid);
        structure(i,1:length(line)) = line;
    end
    [seq1, bulge1, endbulge1] = get_features(structure);
    seqs{seq_no} = seq1;
    pos = findstr(seqd{seq_no}, nuc2int4(seq1));
    if ~isempty(pos)
        lend = length(seqd{seq_no});
        % search on structure for pos
        [id,jd] = dicer_on_structure(pos, lend, structure);
    else
        id = [];
        jd = [];
    end

    plot_structure(structure,id,jd);
    pause

end
return
function [id,jd] = dicer_on_structure(pos, lend, structure)
uphalf = structure(1:2,:);
[j,k] = find(isletter(uphalf));
max_col = max(k);
count = 0;
dicercount = 0;
for col =1: max_col
    fl = find(isletter(uphalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        if count >=pos & count < pos + lend

```

```

        dicercount = dicercount+1;
        id(dicercount) = fl(1);
        jd(dicercount) = col;
    end
end
end
lwhalf = structure(3:4,:);
[j,k] = find(isletter(lwhalf));
max_col = max(k);
for col =max_col:-1:1
    fl = find(isletter(lwhalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        if count >=pos & count < pos + lend
            dicercount = dicercount+1;
            id(dicercount) = fl(1) + 2;
            jd(dicercount) = col;
        end
    end
end
end
return
function plot_structure(structure,id,jd);
yscale = 1.5;
clf
hold on
axis equal
[j,k] = find(isletter(structure));
max_col = max(k);
axis([ 0 max(75,max_col) 0 5*yscale]);
for x = 1:max_col
    for y = 1:4
        text(x,yscale*y,structure(5-y,x)); % so upper appears on top
    end
end
end
for k = 1:length(id);
    H = text(jd(k),yscale*(5-id(k)),structure(id(k),jd(k)));
    set(H,'color',[1 0 0]);
end
return
function [seq, bulge, endbulge] = get_features(structure)
% get sequence as well as bulge structure
%upper half (5' side)
bulge_row = 1; % the row of bulge letters
uphalf = structure(1:2,:);
[j,k] = find(isletter(uphalf));
max_col = max(k);
count = 0;
for col =1: max_col
    fl = find(isletter(uphalf(:,col)));
    if ~isempty(fl)

```

```

        count = count + 1;
        seq(count) = uphalf(fl,col);
        bulge(count) = (fl == bulge_row);
    end
end
% endbulge is coded on the upper half
% go backwards from 3' side to 5' side
endbulge = zeros(size(bulge));
pos = length(bulge);
while bulge(pos) == 1
    endbulge(pos) = 1;
    pos = pos - 1;
end
%lower half
bulge_row = 2; % 4 th line on structure is 2 line on lower half
lwhalf = structure(3:4,:);
[j,k] = find(isletter(lwhalf));
max_col = max(k);
for col =max_col:-1:1
    fl = find(isletter(lwhalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        seq(count) = lwhalf(fl,col);
        bulge(count) = (fl == bulge_row);
        endbulge(count) = 0;
    end
end
return

```

```

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function run_palgrade(zuker_filename,output_filename)
load model_palgrade6_rfam3_human;
fidin = fopen(zuker_filename,'r');
fidout = fopen(output_filename,'w');
seqstot = 1000; %number of sequences to classify each loop
while ~feof(fidin)
    disp('reading structure...');

    [seqs,anti_inds,bulges1,bulges2,endbulges,pal_id,energy,all_pal_ids] = ...
        read_structure_with_id_fid_ce(fidin,seqstot);

    if(~iscell(seqs))
        tt{1} = seqs; seqs = tt; clear tt;
        tt{1} = bulges1; bulges1 = tt; clear tt;
        tt{1} = bulges2; bulges2 = tt; clear tt;
        tt{1} = endbulges; endbulges = tt; clear tt;
    end

    %take as pal only certain length from loop on each side
    if (model.pal_len_to_take_on_each_side ~= -1)
        for i = 1:length(seqs)
            s=seqs{i}; b1=bulges1{i}; b2=bulges2{i}; eb = endbulges{i};
            tt = find(eb==1);
            middle_pos = tt(1)+floor(length(tt)/2);
            ind1 = max(1,middle_pos - model.pal_len_to_take_on_each_side);
            ind2 = min(length(s),middle_pos + model.pal_len_to_take_on_each_side);
            seqs{i}= s(ind1:ind2);
            bulges1{i}=b1(ind1:ind2);
            bulges2{i}=b2(ind1:ind2);
            endbulges{i}=eb(ind1:ind2);
        end
    end

    score = get_palgrade(seqs,bulges1,bulges2,endbulges,energy,model);

    for i = 1:length(score)
        fprintf(fidout,'%d %g ',pal_id(i),score(i));
    end
end
fclose(fidin);
fclose(fidout)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function score = get_palgrade(seqs,bulges1,bulges2,endbulges,energy,model)
if(model.filter_by_min_complexity)
    complexity = pal_complexities(seqs,model.complexity_window_size);
    for i = 1:length(seqs);
        this_c = complexity{i};

```

```

if(min(this_c)<model.complexity_min_min_allowed | (model.filter_by_energy & energy>model.max_energy))
    score(i) = 0;
else
    score(i) = get_this_grade(seqs{i},bulges1{i},bulges2{i},endbulges{i},energy(i),model);
end
end
else
    for i = 1:length(seqs);
        if(model.filter_by_energy & energy>model.max_energy)
            score(i)=0;
        else
            score(i) = get_this_grade(seqs{i},bulges1{i},bulges2{i},endbulges{i},energy(i),model);
        end
    end
end
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function score = get_this_grade(seq,b1,b2,eb,energy,model)
% normalize weights to sum of 1:
G_score = get_G_score(seq,eb,model);
nobulge_score = get_nobulge_score(b1,b2,eb,model);
nobulge_piece_score = get_nobulge_piece_score(b1,b2,eb,model);
score = G_score * nobulge_score * nobulge_piece_score;
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function score = min_max_score(min_v,max_v,dir_flag,value)
if(dir_flag == 1) % the higher the better
    score = (value - min_v)/(max_v - min_v);
elseif(dir_flag == -1) % the lower the better
    score = 1 - ((value - min_v)/(max_v - min_v));
else
    error('min_max_score: dir_flag must be 1 or -1. aborting');
end
if(score<0)
    score = 0;
end
if(score>1)
    score = 1;
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function s = get_G_score(seq,eb,model)
tt = find(eb);
eb_begin = tt(1);
eb_end = tt(end);
index_range = [1:eb_begin-1, eb_end+1:length(seq)];
c = zeros(1,4);
for j = index_range
    c(seq(j)) = c(seq(j)) + 1;
end

```

```

f = c/sum(c); % frequencies of letters
G_freq = f(4);
s = min_max_score(model.min_G_freq,1,1,G_freq);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function s = get_nobulge_score(b1,b2,eb,model);
eff_len = length(b1) - sum(eb); % effective length
t1 = sum(b1)/eff_len;
t2 = sum(b2)/eff_len;
f = 1- t1- t2;
s = min_max_score(model.min_nobulge,1,1,f);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function s = get_nobulge_piece_score(b1,b2,eb,model);
start_arm5 = model.num_nb_per_peice_start_arm5;
start_arm3 = model.num_nb_per_peice_start_arm3;
len = model.num_non_bulged_per_peice_len;
[n5,n3] = num_non_bulged_per_peice(b1, b2, eb, start_arm5,start_arm3,len);
m = min(n5,n3);
if(m>=model.num_non_bulged_per_peice_min)
    s = 1;
else
    s = 0;
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [seqs,anti_inds,bulges_nonsym,bulges_sym,endbulges,pal_id,energy,all_pal_ids] =
read_structure_with_id_fid_ce(fid,seqtot)
% function [seqs,anti_inds,bulges_nonsym,bulges_sym,endbulges,pal_id,energy,all_pal_ids] =
read_structure_with_id_fid_ce(fid,seqtot)
% same as read_structure_withanti_fid but reads file that have before the 4 line zucker draw
% a line giving the pal_id and a line giving the energy.
% all_pal_ids is all ids read from file, whether faulty or not
% new feature: checks that draw is not messed up and if it is gives faulty seq.
% in this check_e version returns faulty seq also when no energy found
Mxplen = 250; % maximal length of palindrom
counter = 0;
seq_no = 0;
seqs = cell(0);
bulges_nonsym= cell(0);
bulges_sym= cell(0);
endbulges = cell(0);
pal_id = zeros(0);
energy = zeros(0);
while ~feof(fid) & seq_no < seqtot
    this_pal_id = str2double(fgetl(fid));
    this_energy = str2double(fgetl(fid));
    if(isnan(this_energy))
        fault_seq_energy = 1;
    else

```

```

    fault_seq_energy = 0;
end
structure = char(4,250);
i = 0;
line = fgetl(fid);
if isempty(line)
    line = 'emptyline';
    fault_seq_emptyline = 1;
else
    fault_seq_emptyline = 0;
end
while(line(1)~= '|') % if emptyline this is always true so will go into loop
    i = i+1;
    structure(i,1:length(line)) = line;
    line = fgetl(fid);
    if isempty(line)
        line = 'emptyline';
        fault_seq_emptyline = 1;
    end
end
if(i~=4)
    fault_seq_numlines = 1;
else
    fault_seq_numlines = 0;
end

fault_seq_struct = 1; % guilty until proven innocent
fault_seq_nuc = 1;
if(fault_seq_numlines == 0 & fault_seq_emptyline==0 & fault_seq_energy==0)
    [seqi, anti_indi, bulge1i, bulge2i, endbulgei,fault_seq_struct] = get_features(structure);
    if(fault_seq_struct==0)
        % this is the old bulge1 and bulge2, now need to correct that
        bulge_nonsym1=bulge1i;
        bulge_sym1=bulge2i;
        for j = 1:length(seqi)
            if(bulge_nonsym1(j))
                if(bulge_sym1(max(1,j-1))) % a neighbor has a bulgesym flag on
                    bulge_sym1(j) = 1;
                    bulge_nonsym1(j) = 0;
                end
            end
        end
        for j = length(seqi):-1:1
            if(bulge_nonsym1(j))
                if(bulge_sym1(min(j+1,length(seqi)))) % a neighbor has a bulgesym flag on
                    bulge_sym1(j) = 1;
                    bulge_nonsym1(j) = 0;
                end
            end
        end
    end
end
end

```

```

        [intseq, fault_seq_nuc] = nuc2int4_new(seqi);
    end
end

if (fault_seq_struct == 0 & fault_seq_nuc == 0 & fault_seq_numlines == 0 & fault_seq_emptyline == 0 &
fault_seq_energy==0)
    seq_no = seq_no + 1;
    seqs{seq_no} = intseq;
    anti_inds{seq_no} = anti_indi;
    bulges_nonsym{seq_no} = bulge_nonsymi;
    bulges_sym{seq_no} = bulge_symi;
    endbulges{seq_no} = endbulgei;
    pal_id(seq_no) = this_pal_id;
    energy(seq_no) = this_energy;
    counter = counter + 1;
    all_pal_ids(counter) = this_pal_id;
else
    disp(['faulty seq on pal id ' num2str(this_pal_id)])
    if(fault_seq_energy)
        disp(['reason is that there was no energy']);
    elseif(fault_seq_emptyline)
        disp(['reason is that there was an empty line in zucker']);
    elseif(fault_seq_numlines)
        disp(['reason is that there were not 4 lines in the draw']);
    elseif(fault_seq_struct)
        disp(['reason is that draw was messed has nuc in pair and bulge at the same time']);
    elseif(fault_seq_nuc)
        disp(['reason is that there was an illegal letter in the seq']);
    end
    counter = counter + 1;
    all_pal_ids(counter) = this_pal_id;
end
end
return
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [seq, anti_ind, bulge1, bulge2, endbulge, fault_seq] = get_features(structure)
% get sequence as well as bulge structure
fault_seq = 0;
%upper half (5' side)
bulge_row = 1; % the row of bulge letters
bulge_row_opposite = 4;
uphalf = structure(1:2,:);
[j,k] = find(isletter(uphalf));
max_col = max(k);
tmpmat = zeros(2,max_col);
count = 0;
for col =1: max_col
    fl = find(isletter(uphalf(:,col)));
    if (length(fl)>1);

```

```

    fault_seq = 1;
    seq=nan;anti_ind=nan;bulge1=nan;bulge2=nan;endbulge=nan;
    return;
end;
if ~isempty(fl)
    count = count + 1;
    seq(count) = uphalf(fl,col);
    bulge = (fl == bulge_row);
    if(bulge)
        tmpmat(1,col) = 0;
    else
        tmpmat(1,col) = count;
    end
    bulge1(count) = 0;
    bulge2(count) = 0;
    if bulge & isletter(structure(bulge_row_opposite,col))
        bulge2(count) = 1;
    elseif bulge & ~isletter(structure(bulge_row_opposite,col))
        bulge1(count) = 1;
    end
end
end
end
% endbulge is coded on the upper half
% go backwards form 3' side to 5' side
endbulge = zeros(size(bulge1));
lwhalf = structure(3:4,:);
pos = length(bulge1);
while bulge1(pos) == 1
    endbulge(pos) = 1;
    bulge1(pos) = 0;
    pos = pos - 1;
end
%lower half
bulge_row = 2; % 4 th line on structure is 2 line on lower half
bulge_row_opposite = 1;
[j,k] = find(isletter(lwhalf));
max_col = max(k);
for col =max_col:-1:1
    fl = find(isletter(lwhalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        seq(count) = lwhalf(fl,col);
        bulge = (fl == bulge_row);
        if(bulge)
            tmpmat(2,col) = 0;
        else
            tmpmat(2,col) = count;
        end
        bulge1(count) = 0;
        bulge2(count) = 0;
    end
end

```

```

    if bulge & isletter(structure(bulge_row_opposite,col))
        bulge2(count) = 1;
    elseif bulge & ~isletter(structure(bulge_row_opposite,col))
        bulge1(count) = 1;
    end
    endbulge(count) = 0;
end
end
anti_ind = zeros(size(bulge1));
for col=1:max_col
    if(tmpmat(1,col))
        anti_ind(tmpmat(1,col)) = tmpmat(2,col);
        anti_ind(tmpmat(2,col)) = tmpmat(1,col);
    end
end
return
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function c = pal_complexities(seqs,winsize,endbulges)
%c = pal_complexities(seqs,winsize,endbulges)
%c = pal_complexities(seqs,winsize)
%second version looks also at endbulge, first ignores the letters there
%c is a cell array where c{i} is a vector holding the complexity measures of
% all windows fitting in the seq of the ith pal
Ns = 4; %number of states
if nargin == 3
    omit_endbulge = 1;
else
    omit_endbulge = 0;
end
%test if single sequence
if ~iscell(seqs)
    t = cell(1);
    t{1} = seqs;
    seqs = t;
    if omit_endbulge == 1
        t = cell(1);
        t{1} = endbulges;
        endbulges = t;
    end
    clear t
end
c = cell(0);
for i = 1:length(seqs)
    this_c = [];
    seqsi = seqs{i};
    if omit_endbulge
        eb = find(endbulges{i});
        eb_begin = eb(1);
        eb_end = eb(end);
    end
end

```

```

for j=1:eb_begin-1-(winsize-1)
    this_winsseq = seqsi(j:j+winsize-1);
    this_c = [this_c,get_seq_complexity(this_winsseq)];
end
for j=eb_end+1:length(seqsi)-(winsize-1)
    this_winsseq = seqsi(j:j+winsize-1);
    this_c = [this_c,get_seq_complexity(this_winsseq)];
end
else
    for j=1:length(seqsi)-(winsize-1)
        this_winsseq = seqsi(j:j+winsize-1);
        this_c = [this_c,get_seq_complexity(this_winsseq)];
    end
end
c{i} = this_c;
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function c = get_seq_complexity(seq)
p = zeros(1,4);
for j=1:length(seq)
    p(seq(j)) = p(seq(j)) + 1;
end
p = p/sum(p); % letter freq in this seq
c = entropy(p); % complexity is simply the entropy of the seq in the window

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [n5,n3] = ...
    num_non_bulged_per_peice(bulges1, bulges2, endbulges, piece_start_arm5, piece_start_arm3 ,piece_len)
if(~iscell(bulges1))
    tt{1} = bulges1;
    bulges1 = tt;
    clear tt;
    tt{1} = bulges2;
    bulges2 = tt;
    clear tt;

tt{1} = endbulges;
    endbulges = tt;
    clear tt;
end
numseqs = length(bulges1);
for i=1:numseqs
    eb=endbulges{i}; b1 = bulges1{i}; b2 = bulges2{i};
    tt=find(eb==1);
    loop_start=tt(1);
    loop_end=tt(end);
    nb = 1-max(b1,b2);
    s5 = max(loop_start-piece_start_arm5,1);

```

[illegible]

[illegible]

```

%save_model
% homology = nan is considered 0 for histogram.
% also scores of edist and 2stage nan is taken as 0
paramfile = 'params6';
eval(paramfile);
model = model_params;
if(1)
set_name = 'human_pals_rfam3';
fid_k = fopen(['c:\rosetta_alg\data_baseline_1_3_04\' set_name '_zucker_draw.txt'],'r')
[seqs_k,anti_inds_k,bulges1_k,bulges2_k,endbulges_k,pal_id_k,energy_k,all_pal_ids_k] = ...
    read_structure_with_id_fid_ce(fid_k,1000);
fclose(fid_k);
if(length(pal_id_k)~=length(all_pal_ids_k))
    error('in training data do not allow faulty seqs, take out of there');
end
if (model_params.pal_len_to_take_on_each_side ~= -1)
    for i = 1:length(seqs_k)
        s=seqs_k{i}; b1=bulges1_k{i}; b2=bulges2_k{i}; eb = endbulges_k{i};
        tt = find(eb==1);
        middle_pos = tt(1)+floor(length(tt)/2);
        ind1 = max(1,middle_pos - model.pal_len_to_take_on_each_side);
        ind2 = min(length(s),middle_pos + model.pal_len_to_take_on_each_side);
        seqs_k{i}= s(ind1:ind2);
        bulges1_k{i}=b1(ind1:ind2);
        bulges2_k{i}=b2(ind1:ind2);
        endbulges_k{i}=eb(ind1:ind2);
    end
end
fid_1000= fopen('c:\rosetta_alg\data_baseline_1_3_04\chr_14_15_rand1583_pals_zucker_draw.txt','r');
[seqs_1000,anti_inds_1000,bulges1_1000,bulges2_1000,endbulges_1000,pal_id_1000,energy_1000,all_pal_ids_1000] = ...
    read_structure_with_id_fid_ce(fid_1000,1000);
fclose(fid_1000);
if (model_params.pal_len_to_take_on_each_side ~= -1)
    for i = 1:length(seqs_1000)
        s=seqs_1000{i}; b1=bulges1_1000{i}; b2=bulges2_1000{i}; eb = endbulges_1000{i};
        tt = find(eb==1);
        middle_pos = tt(1)+floor(length(tt)/2);
        ind1 = max(1,middle_pos - model.pal_len_to_take_on_each_side);
        ind2 = min(length(s),middle_pos + model.pal_len_to_take_on_each_side);
        seqs_1000{i}= s(ind1:ind2);
        bulges1_1000{i}=b1(ind1:ind2);
        bulges2_1000{i}=b2(ind1:ind2);
        endbulges_1000{i}=eb(ind1:ind2);
    end
end
end %if 0/1
save model_palgrade6_rfam3_human model
[score_known] = get_palgrade(seqs_k,bulges1_k,bulges2_k,...
    endbulges_k,energy_k,model);

```

```

[score_1000] = get_palgrade(seqs_1000,bulges1_1000,bulges2_1000,...
    endbulges_1000,energy_1000,model);
hist_vec = [0:0.01:1];
cos1 = 0.5;
cos2 = 0.8;
[n_known,x] = hist(score_known,hist_vec);
n_known_norm = n_known/sum(n_known);
[n_1000,x] = hist(score_1000,hist_vec);
n_1000_norm = n_1000/sum(n_1000);
figure;
plot(x,n_known_norm,'b-o',x,n_1000_norm,'r-*','linewidth',2);
axis_vec = [min(hist_vec), max(hist_vec), 0 ,1];
axis_vec = [min(hist_vec), 0.2, 0 ,1];
axis(axis_vec);
legend('known','bg');
print -djpeg mfold_known_background

```

```

using System;
using BasicTypes;
using IndexService;
using IndexManager;
using GPLogging;
using DataBaseGate;
using System.Collections;
using SystemGate;
namespace FlowManager
{
    /// <summary>
    /// Summary description for MirBsFinder.
    /// </summary>
    public class MirBsFinder
    {
        private IndexMgr m_indexMgr;
        private string m_utrLogicTbl;
        private OrthologyMap m_orthologyMap;
        private SeqsWinIndex m_utrIndex;
        private MirUtrBsCal bsCal;
        private WordEditMapper m_wordEditMap;
        private UtrMirPvalHash m_utrPvalCalHash;
        private UtrLogicTableNamesMap m_utrTableLogicNameMap;
        private float m_maxPvalThresh;
        public MirBsFinder(IndexMgr indexMgr, string utrLogicTbl,
            SeqsWinIndex utrIndex,
            OrthologyMap orthologyMap,
            UtrLogicTableNamesMap utrTableLogicNameMap,
            float maxPvalThresh)
        {
            try
            {
                if (utrIndex.WindowSize != MirUtrBsPvalCal.UTR_INDEX_WINDOW_SIZE)
                    throw new ArgumentException("got index of utr not in the size of the static utrBsPval");
                m_indexMgr = indexMgr;
                m_utrIndex = utrIndex;
                m_orthologyMap = orthologyMap;
                m_maxPvalThresh = maxPvalThresh;
                bsCal = new MirUtrBsCal(utrIndex);
                m_utrLogicTbl = utrLogicTbl;
                m_wordEditMap = new WordEditMapper(utrIndex.WindowSize - 1);
                m_utrPvalCalHash = new UtrMirPvalHash(m_utrIndex);
                m_utrTableLogicNameMap = utrTableLogicNameMap;
            }
            catch (Exception e)
            {
                GPLogger.Instance.Error("The build of the mirBsFinder failed",e);
                throw e;
            }
        }
    }
}

```

```

/// <summary>
/// find bss for the mir
/// </summary>
/// <param name="mirSeq"> the mir sequence to search</param>
/// <param name="allowedTargetUtrIds">if null or length == 0 then all utrs. must be sorted.
/// all the utrs must appear in the utr table </param>
/// <returns></returns>
public BSSet FindMirBs(Mir mir,bool runOrthology, out MirUtrOrthologySet mirUtrOrthologySet,
    params int[] sortedAllowedTargetUtrIds)
{
    string mirSeq = mir.Seq;
    BSSet bsSet= new BSSet();
    mirUtrOrthologySet = new MirUtrOrthologySet();
    // for the false discovery rate
    int targetUtrsNum;
    // how many utrs were used for the cal
    if (sortedAllowedTargetUtrIds == null ||
        sortedAllowedTargetUtrIds.Length == 0)
    {
        targetUtrsNum = m_utrIndex.Count;
    }
    else
        targetUtrsNum = sortedAllowedTargetUtrIds.Length;
    FloatSet pValArr = new FloatSet(targetUtrsNum);
    int winSize = MirUtrBsPvalCal.UTR_INDEX_WINDOW_SIZE -1;
    string perfectMatchStr = mirSeq.Substring(MirUtrBsPvalCal.PM_START, winSize);
    int perfectMatchKey = IndexData.WordToInt(perfectMatchStr,winSize);
    // the different relative words array
    MapperItem[] mappedWords = m_wordEditMap.GetDerivedWords(perfectMatchKey);
    // the different seqs position array
    WordSeqPositions[] seqPosArr = new WordSeqPositions[mappedWords.Length];
    IndexHashtable utrPosHash;
    for (int i = 0; i < mappedWords.Length; ++i)
    {
        utrPosHash = m_utrIndex.GetWordPositions(mappedWords[i].WordKey);
        seqPosArr[i] = new WordSeqPositions(mappedWords[i],utrPosHash.First);
    }
    // all the params for one utr
    WordSeqPositions[] curUtrSeqPosArr;
    BSSet curBsSet;
    MirUtrOrthologySet curMirUtrOrthologySet;
    int curUtrPosArrCnt;
    MirUtrBsPvalCal curUtrPvalCal;
    int allowedTargetUtrIdsIndex = 0;
    bool isPerfectMatchBS = false;
    // for each utr
    // UTR id must be above zero
    for (int minUtrId = MinUtrId(seqPosArr);
        minUtrId > -1;
        minUtrId = MinUtrId(seqPosArr))

```

```

{
if (sortedAllowedTargetUtrIds == null ||
    sortedAllowedTargetUtrIds.Length == 0 ||
    IsAllowedTargetUtr(minUtrId, sortedAllowedTargetUtrIds, ref allowedTargetUtrIdsIndex))
{
    int minUtrIdWordNum = 0;

    // count number of different words in same utr
    // (for utr with minimal id)
    for (int i = 0; i < seqPosArr.Length; ++i)
    {
        if (seqPosArr[i].SeqPositions != null && seqPosArr[i].SeqPositions.Id == minUtrId)
            ++minUtrIdWordNum;
    }
    curUtrSeqPosArr = new WordSeqPositions[minUtrIdWordNum];
    curUtrPosArrCnt = 0;
    for (int i = 0; i < seqPosArr.Length; ++i)
    {
        if (seqPosArr[i].SeqPositions != null && seqPosArr[i].SeqPositions.Id == minUtrId)
        {
            curUtrSeqPosArr[curUtrPosArrCnt] = new WordSeqPositions(seqPosArr[i]);
            seqPosArr[i].SeqPositions = seqPosArr[i].SeqPositions.Next;
            ++curUtrPosArrCnt;
        }
    }
    curBsSet = bsCal.CalBss(curUtrSeqPosArr, minUtrId, mirSeq);
    curUtrPvalCal = m_utrPvalCalHash[minUtrId];
    // TODO catch for running with bugs or write a method that checdk it in advance
    if (curUtrPvalCal == null)
        throw new ArgumentException("utr PvalCal not in hash");
    curUtrPvalCal.CalPval(curBsSet);
    // adding the pVal to the pVal array
    if (curBsSet != null && curBsSet.Count > 0)
        pValArr.Add(curBsSet[0].UtrPval);
    isPerfectMatchBS = CallsPerfectMatchBS(curBsSet);
    if (curBsSet != null && curBsSet.Count > 0 &&
        (curBsSet[0].UtrPval <=
         m_maxPvalThresh || isPerfectMatchBS) )
    {
        // add to table if pval < theresh add all else only perfect match
        if (curBsSet[0].UtrPval <= m_maxPvalThresh)
        {
            bsSet.AddRange(curBsSet);
        }
        else
        {
            bsSet.AddRange(curBsSet.GetPMBSSubSet());
        }
    }
    if (runOrthology)
    {

```

```

// run orthology
curMirUtrOrthologySet =
    CheckOrthology(curBsSet, mirSeq, minUtrId);
mirUtrOrthologySet.AddRange(curMirUtrOrthologySet);
}
}

isPerfectMatchBS = false;
}
else
{
    for (int i = 0; i < seqPosArr.Length; ++i)
    {
        if (seqPosArr[i].SeqPositions != null && seqPosArr[i].SeqPositions.Id == minUtrId)
        {
            seqPosArr[i].SeqPositions = seqPosArr[i].SeqPositions.Next;
        }
    }
}
}
CalFalseDiscoveryRate(mirUtrOrthologySet,bsSet, pValArr, targetUtrsNum);
CalMirBSOrthologyScore(mir,mirUtrOrthologySet,bsSet,targetUtrsNum);
return bsSet;
}
private bool CallsPerfectMatchBS(BSSet bsSet)
{
    if (bsSet == null)
        return false;
    foreach (BS bs in bsSet)
    {
        if (bs.BSPMScore >= BS.PERFECT_MATCH_MIN_THRESH)
            return true;
    }
    return false;
}
public bool IsAllowedTargetUtr(int utrId,
int[] sortedAllowedTargetUtrIds,
ref int allowedTargetUtrIdsIndex)
{
    for (; allowedTargetUtrIdsIndex < sortedAllowedTargetUtrIds.Length; ++allowedTargetUtrIdsIndex)
    {
        if (utrId == sortedAllowedTargetUtrIds[allowedTargetUtrIdsIndex])
        {
            ++allowedTargetUtrIdsIndex;
            return true;
        }
        else if (utrId < sortedAllowedTargetUtrIds[allowedTargetUtrIdsIndex])
        {
            return false;
        }
    }
}

```

```

    }
    return false;
}

public MirUtrOrthologySet CheckOrthology(BSSet bsSet,
    string mirSeq, int utrId)
{
    if (bsSet == null || bsSet.Count == 0)
        throw new ArgumentException("CheckOrthology got empty bs set");
    MirUtrOrthologySet retMirUtrOrthologySet = new MirUtrOrthologySet();
    UtrKey orgUtrKey = bsSet[0].UtrKey;

    OrthologFamily family = m_orthologyMap.GetOrthologFamily(orgUtrKey);
    // no
    if (family == null)
    {
        // makes the log to big
        //GLogger.Instance.Warn("NO Orthology data was found for utr id: " + orgUtrKey.UtrId + " of organism:" +
orgUtrKey.Organism);
        return retMirUtrOrthologySet;
    }
    /*else // makes the log to big
    {
        GLogger.Instance.Info("Orthology data was found for utr id: " + orgUtrKey.UtrId + " of organism:" +
orgUtrKey.Organism);
    }*/
    string[] orthologOrganisms = family.GetOrthologOrganisms(orgUtrKey.Organism);
    WordSeqPositions[] curWordSeqPositions;
    MirUtrBsPvalCal curMirUtrBsPvalCal;
    SeqsWinIndex curSeqsWinIndex;
    BSSet curBsSet;
    int curOrthologUtrsNum;
    float curBestPval;
    float curBestPvalThresh;
    int bestPvalUtrId;
    string bestPvalTranscriptId = null;
    string bestPvalExternalDB = null;
    string curPvalCalStr;
    foreach(string organism in orthologOrganisms)
    {
        curOrthologUtrsNum = 0;
        curBestPval = -1;
        curBestPvalThresh = -1;
        bestPvalUtrId = -1;
        UtrKey[] orthologUtrs = family.GetUtrsKeyByOrganism(organism);
        string tableLogicName = m_utrTableLogicNameMap[organism];
        if (tableLogicName == null)
            throw new ArgumentException("Logic table names map does not contain: " + organism);
        curSeqsWinIndex = m_indexMgr.GetIndex(tableLogicName, MirUtrBsPvalCal.UTR_INDEX_WINDOW_SIZE);
        MirUtrBsCal curBsCal = new MirUtrBsCal(curSeqsWinIndex);
        foreach(UtrKey utrKey in orthologUtrs)

```

```

{
    curWordSeqPositions =
        MirBsFinder.CalMirUtrSeqPositions(curSeqsWinIndex, m_wordEditMap, utrKey.UtrId, mirSeq);
    curBsSet = curBsCal.CalBss(curWordSeqPositions, utrKey.UtrId, mirSeq);
    curPvalCalStr = curSeqsWinIndex.GetAttribute(utrKey.UtrId, DBConsts.UTR_PVAL_CAL).ToString();
    curMirUtrBsPvalCal = MirUtrBsPvalCal.FromString(curPvalCalStr);
    // TODO consider to leave the method
    if (curMirUtrBsPvalCal == null)
    {
        try
        {
            throw new ArgumentException("The ortholog utr table (indexing): " + tableLogicName + " for utr id: " + utrKey.UtrId + "
the pValCal is empty or from old version");
        }
        catch (Exception e)
        {
            GPLLogger.Instance.Error(e);
        }
    }
    curMirUtrBsPvalCal.CalPval(curBsSet);
    ++curOrthologUtrsNum;
    if (curBestPval == -1)
    {
        if (curBsSet.Count == 0)
        {
            curBestPval = 1;
            curBestPvalThresh = -1;
            bestPvalUtrId = utrKey.UtrId;
            bestPvalTranscriptId = curSeqsWinIndex.GetAttribute(utrKey.UtrId, DBConsts.UTR_TRANSCRIPT_ID).ToString();
            bestPvalExternalDB = curSeqsWinIndex.GetAttribute(utrKey.UtrId, DBConsts.UTR_EXTERNAL_DB).ToString();
        }
        else
        {
            curBestPval = curBsSet[0].UtrPval;
            curBestPvalThresh = curBsSet[0].UtrThresh;
            bestPvalUtrId = utrKey.UtrId;
            bestPvalTranscriptId = curSeqsWinIndex.GetAttribute(utrKey.UtrId, DBConsts.UTR_TRANSCRIPT_ID).ToString();
            bestPvalExternalDB = curSeqsWinIndex.GetAttribute(utrKey.UtrId, DBConsts.UTR_EXTERNAL_DB).ToString();
        }
    }
    else if (curBsSet != null &&
        curBsSet.Count > 0 &&
        curBestPval > curBsSet[0].UtrPval)
    {
        curBestPval = curBsSet[0].UtrPval;
        curBestPvalThresh = curBsSet[0].UtrThresh;
        bestPvalUtrId = utrKey.UtrId;
        bestPvalTranscriptId = curSeqsWinIndex.GetAttribute(utrKey.UtrId, DBConsts.UTR_TRANSCRIPT_ID).ToString();
        bestPvalExternalDB = curSeqsWinIndex.GetAttribute(utrKey.UtrId, DBConsts.UTR_EXTERNAL_DB).ToString();
    }
}

```

```

}
retMirUtrOrthologySet.Add(
    new MirUtrOrthology(mirSeq,bsSet[0].UtrId,bsSet[0].UtrPval,
        bsSet[0].UtrThresh,organism,
        curOrthologUtrsNum,
        bestPvalUtrId,curBestPval,
        curBestPvalThresh,
        bestPvalTranscriptId, bestPvalExternalDB,bsSet[0].UtrOrganism));
}
return retMirUtrOrthologySet;
}
private void CalMirBSOrthologyScore(Mir mir,
    MirUtrOrthologySet mirUtrOrthologySet,
    BSSet bsSet, int targetUtrsNum)
{
    // can't compute
    if (bsSet == null || bsSet.Count == 0 ||
        mirUtrOrthologySet == null || mirUtrOrthologySet.Count == 0 )
    {
        mir.BsOrthologyScore = -1;
        return;
    }
    int foundBsUtrsNum;
    int foundOrthologUtrsNum;
    int foundGoodOrthologUtrsNum;
    float minMirBsOrthologyScore = 1;
    float curMirBsOrthologyScore;
    Hashtable foundBsUtrs = new Hashtable();
    foreach(BS bs in bsSet)
    {
        if(!foundBsUtrs.ContainsKey(bs.UtrKey.Organism + bs.UtrKey.UtrId.ToString()))
            foundBsUtrs.Add(bs.UtrKey.Organism + bs.UtrKey.UtrId.ToString(),1);
    }
    foundBsUtrsNum = foundBsUtrs.Count;
    foundBsUtrs = null;
    Hashtable allOrthologOrganisms = new Hashtable();
    foreach(MirUtrOrthology orthology in mirUtrOrthologySet)
    {
        if(!allOrthologOrganisms.ContainsKey(orthology.OrthologOrganism))
            allOrthologOrganisms.Add(orthology.OrthologOrganism,orthology.OrthologOrganism);
    }
    // check best value for each ortholog organism
    string orthologOrganism;
    foreach(object orthologOrganismObj in allOrthologOrganisms.Keys)
    {
        orthologOrganism = orthologOrganismObj.ToString();
        Hashtable foundOrthologUtrs = new Hashtable();
        foreach(MirUtrOrthology orthology in mirUtrOrthologySet)
        {
            if(!foundOrthologUtrs.ContainsKey(orthology.OrgUtrOrganism + orthology.OrgUtrId) &&

```

```

        orthology.OrgUtrPval < m_maxPvalThresh &&
        orthology.OrthologOrganism == orthologOrganism)
        foundOrthologUtrs.Add(orthology.OrgUtrOrganism + orthology.OrgUtrId,1);
    }
    foundOrthologUtrsNum = foundOrthologUtrs.Count;
    foundOrthologUtrs = null;
    Hashtable foundGoodOrthologUtrs = new Hashtable();
    foreach(MirUtrOrthology orthology in mirUtrOrthologySet)
    {
        if(!foundGoodOrthologUtrs.ContainsKey(orthology.OrgUtrOrganism + orthology.OrgUtrId) &&
        orthology.OrgUtrPval < m_maxPvalThresh &&
        orthology.OrthologBestUtrPval < m_maxPvalThresh * MirUtrOrthology.GOOD_ORTHOLOGY_PVAL_RATIO &&
        orthology.OrthologOrganism == orthologOrganism)
        foundGoodOrthologUtrs.Add(orthology.OrgUtrOrganism + orthology.OrgUtrId,1);
    }
    foundGoodOrthologUtrsNum = foundGoodOrthologUtrs.Count;
    foundGoodOrthologUtrs = null;
    curMirBsOrthologyScore = (float) GPMath.BernoulliCDF(foundGoodOrthologUtrsNum,foundOrthologUtrsNum,
((float)foundBsUtrsNum) / targetUtrsNum);
    if (curMirBsOrthologyScore < minMirBsOrthologyScore)
        minMirBsOrthologyScore = curMirBsOrthologyScore;

    }
    mir.BsOrthologyScore = minMirBsOrthologyScore;
}

public void CalFalseDiscoveryRate(MirUtrOrthologySet mirUtrOrthologySet, BSSet bsSet, FloatSet pValArr, int
targetUtrsNum)
{
    FalseDiscoveryRateCal falseDiscoveryRateCal = new FalseDiscoveryRateCal(pValArr,targetUtrsNum);
    foreach(MirUtrOrthology mirUtrOrthology in mirUtrOrthologySet)
    {
        mirUtrOrthology.FalseDiscoveryRate = falseDiscoveryRateCal.CalFalseDiscoveryRate(mirUtrOrthology.OrgUtrPval);
    }
    foreach(BS bs in bsSet)
    {
        bs.UtrFalseDiscoveryRate = falseDiscoveryRateCal.CalFalseDiscoveryRate(bs.UtrPval);
    }
}
/*
private void DeleteFromBsSetByPvalThresh(BSSet bsSet, float pValThresh)
{
    if (bsSet == null || bsSet.Count == 0 || bsSet[0].UtrPval <= pValThresh)
        return;
    else
    {
        bsSet = new BSSet();
        return;
    }
}
*/

```

```

public static WordSeqPositions[] CalMirUtrSeqPositions(
    SeqsWinIndex utrIndex, WordEditMapper wordEditMap,
    int utrId, string mirSeq)
{
    int winSize = MirUtrBsPvalCal.UTR_INDEX_WINDOW_SIZE - 1;
    string perfectMatchStr = mirSeq.Substring(MirUtrBsPvalCal.PM_START, winSize);
    int perfectMatchKey = IndexData.WordToInt(perfectMatchStr, winSize);
    if (perfectMatchKey == -1)
        throw new ArgumentException("illegal mir seq in the perfect match");

    // the different relative words array
    MapperItem[] mappedWords = wordEditMap.GetDerivedWords(perfectMatchKey);
    // the different seqs position array
    WordSeqPositions[] wordSeqPosArr = new WordSeqPositions[mappedWords.Length];
    for (int i = 0; i < mappedWords.Length; ++i)
    {
        wordSeqPosArr[i] =
            new WordSeqPositions(mappedWords[i],
                utrIndex.GetWordPositionsById(mappedWords[i].WordKey, utrId));
    }
    return wordSeqPosArr;
}
// -1 if all are null
private int MinUtrId(WordSeqPositions[] seqPosArr)
{
    int minUtrId = -1;
    for (int i = 0; i < seqPosArr.Length; ++i)
    {
        if (seqPosArr[i].SeqPositions != null)
        {
            if (minUtrId == -1)
                minUtrId = seqPosArr[i].SeqPositions.Id;
            else
                minUtrId = Math.Min(minUtrId, seqPosArr[i].SeqPositions.Id);
        }
    }
    return minUtrId;
}
}
}
using System;
namespace BasicTypes
{
    /// <summary>
    ///
    /// </summary>
    public class BS : Nts, IComparable
    {
        public static float PERFECT_MATCH_MIN_THRESH = 0.9F;
        protected Nts m_srcMirSeq; //id of the mir which ties to the bs
    }
}

```

```

protected int m_bsPosition;
protected string m_bsDraw;
protected float m_bsScore = 0;
protected float m_bsPMScore = 0;
protected float m_bsMirFiveSideScore = 0;
protected float m_bsMirThreeSideScore = 0;
protected bool m_usedForPValCal = false;
protected Utr m_utr;
public BS(int utrId,int utrSide,string geneName,string utrOrganism,
    string utrTranscriptId, string utrExternalDb,
    string bsSeq,string mirSeq,int bsPosition,
    float bsScore,float bsPMScore,float bsMirFiveSideScore,
    float bsMirThreeSideScore, string bsDraw) :
    this(utrId, utrSide, geneName, utrOrganism,utrTranscriptId,utrExternalDb, -1, -1, -1,
    bsSeq,mirSeq,bsPosition,
    bsScore, bsPMScore,bsMirFiveSideScore,
    bsMirThreeSideScore, bsDraw, false)
{}
public BS(int utrId,int utrSide,string geneName, string utrOrganism,
    string utrTranscriptId, string utrExternalDb,
    float utrPval,float utrThresh, float falseDiscoveryRate,
    string bsSeq,string mirSeq,int bsPosition,
    float bsScore,float bsPMScore,float bsMirFiveSideScore,
    float bsMirThreeSideScore, string bsDraw,bool usedForPValCal) : base(bsSeq)
{
    m_utr = new Utr(utrId, utrSide, geneName,utrOrganism,utrTranscriptId,utrExternalDb,utrPval, utrThresh,
falseDiscoveryRate);
    m_srcMirSeq = new Nts(mirSeq);
    m_bsDraw = bsDraw;
    m_bsPosition = bsPosition;
    m_bsScore = bsScore;
    m_bsMirFiveSideScore = bsMirFiveSideScore;
    m_bsMirThreeSideScore = bsMirThreeSideScore;
    // TODO is needed?
    m_bsPMScore = bsPMScore;
    m_usedForPValCal = usedForPValCal;
}
public float UtrFalseDiscoveryRate
{
    get {return m_utr.FalseDiscoveryRate;}
    set {m_utr.FalseDiscoveryRate=value;}
}
public int UtrId
{
    get {return m_utr.Id;}
    set {m_utr.Id=value;}
}
public int UtrSideInt
{
    get {return m_utr.SideInt;}

```

```

    set {m_utr.SideInt = value;}
}
public string UtrSideStr
{
    get {return m_utr.SideStr;}
    set {m_utr.SideStr = value;}
}
public string GeneName
{
    get {return m_utr.GeneName;}
    set {m_utr.GeneName=value;}
}
public string UtrOrganism
{
    get { return m_utr.Organism; }
    set { m_utr.Organism = value; }
}
public string UtrTranscriptId
{
    get { return m_utr.TranscriptId; }
    set { m_utr.TranscriptId = value; }
}
public string UtrExternalDb
{
    get { return m_utr.ExternalDb; }
    set { m_utr.ExternalDb = value; }
}
public UtrKey UtrKey
{
    get
    {
        return m_utr.UtrKey;
    }
}
public float UtrThresh
{
    get {return m_utr.Thresh;}
    set {m_utr.Thresh = value;}
}
public float UtrPval
{
    get {return m_utr.Pval;}
    set {m_utr.Pval=value;}
}
public Utr Utr
{
    get {return m_utr;}
    set {m_utr = value;}
}
public bool UsedForPValCal

```

```

{
    get {return m_usedForPValCal;}
    set {m_usedForPValCal=value;}
}
public int UtrPosition
{
    get { return m_bsPosition; }
    set { m_bsPosition = value; }
}
public string MirSeq
{
    get {return m_srcMirSeq.Seq;}
    set { m_srcMirSeq.Seq = value; }
}
public Nts MirNts
{
    get {return m_srcMirSeq;}
    set { m_srcMirSeq = value; }
}
public string BSDraw
{
    get {return m_bsDraw;}
    set {m_bsDraw = value;}
}
public float BSScore
{
    get {return m_bsScore;}
    set {m_bsScore=value;}
}
public float BSPMScore
{
    get {return m_bsPMScore;}
    set {m_bsPMScore=value;}
}
public float BsMirFiveSideScore
{
    get { return m_bsMirFiveSideScore; }
    set { m_bsMirFiveSideScore =value; }
}
public float BsMirThreeSideScore
{
    get { return m_bsMirThreeSideScore; }
    set { m_bsMirThreeSideScore =value; }
}
/*
public float Ratio
{
    get {return m_ratio;}
    set {m_ratio=value;}
}

```

```

public int NumMirBulges
{
    get {return m_num_mir_bulges;}
    set {m_num_mir_bulges=value;}
}
public int NumTargertBulges
{
    get {return m_num_target_bulges;}
    set {m_num_target_bulges=value;}
}
public int SumMirTailLens
{
    get {return m_sum_mir_tail_lens;}
    set {m_sum_mir_tail_lens=value;}
}
public float BulgeKernelMir
{
    get {return m_bulge_kernel_mir;}
    set {m_bulge_kernel_mir=value;}
}
public int NumGts
{
    get {return m_num_gts;}
    set {m_num_gts=value;}
} */
#region IComparable Members
public int CompareTo(object obj)
{
    if(obj is BS)
    {
        BS temp = (BS) obj;
        int compare = m_utr.CompareTo(temp.Utr);
        if (compare == 0)
            compare = m_bsPosition.CompareTo(temp.UtrPosition);
        if (compare == 0)
        {
            if (base.Length < temp.Length)
                compare = -1;
            else if (base.Length > temp.Length)
                return 1;
        }
        return compare;
    }

    throw new ArgumentException("object is not a BS");
}
#endregion
}
}
using System;

```

```

namespace BasicTypes
{
    /// <summary>
    ///
    /// </summary>
    public class Nts
    {
        protected enum CharE {A,G,T,C,LEN}
        protected string m_nts =null;
        protected string m_invRevNts = null;
        protected float m_complexity = 0;
        protected bool m_complexityWasCal =false;
        // create null nts sequence
        public Nts()
        {}

        public Nts(string nts)
        {
            // TODO add checking for legal nts seq (a g t c n z )
            m_nts = nts;
        }
        public static string InvRev(string nts)
        {
            if (nts == null)
                return null;
            char[] invRevArr=new char[nts.Length];
            char curChr;
            int index=0;
            for(int i=nts.Length-1;i>=0;--i)
            {
                curChr=nts[i];
                if(curChr == 'a' || curChr == 'A')
                    invRevArr[index]='T';
                else if(curChr == 't' || curChr == 'T')
                    invRevArr[index]='A';
                else if(curChr == 'G' || curChr == 'g')
                    invRevArr[index]='C';
                else if(curChr == 'c' || curChr == 'C')
                    invRevArr[index]='G';
                else
                    invRevArr[index]=curChr;
                ++index;
            }
            return new string(invRevArr);
        }
        public void ToInvRev()
        {
            // bug fixed 7.3.03
            if (m_invRevNts != null)

```

```

{
    string orgSeq = m_nts;
    m_nts = m_invRevNts;
    m_invRevNts = orgSeq;
}
else
    m_nts = InvRev(m_nts);
}

public string Seq
{
    get
    {
        return m_nts;
    }
    set
    {
        // TODO consider if needed - if not cancel
        m_nts = value;
        m_invRevNts = null;
    }
}

public string InvRevSeq
{
    get
    {
        if (m_invRevNts == null)
            m_invRevNts = InvRev(m_nts);
        return m_invRevNts;
    }
}

public int Length
{
    get
    {
        if (m_nts == null)
            return 0;
        return m_nts.Length;
    }
}

public float Complexity
{
    get
    {
        if (!m_complexityWasCal)
        {
            m_complexity = CalComplexity();
            m_complexityWasCal = true;
        }
        return m_complexity;
    }
}

```

```

}
}
private float CalComplexity()
{
    if (m_nts == null)
        return 0;
    int [,] secondOrderStat = new int[(int)CharE.LEN+1,(int)CharE.LEN+1];
    int matrixLen = (int) CharE.LEN;
    for ( int i = 0 ; i < matrixLen ; ++i )
        for ( int j = 0 ; j < matrixLen ; ++j )
            secondOrderStat[i,j] = 0;
    for ( int n = 0 ; n < m_nts.Length-1 ; ++n )
        secondOrderStat[(int)CharEnum(m_nts[n]),(int)CharEnum(m_nts[n+1])]++;
    int secondOrderStatScore;
    int max1 = 0;
    int max2 = 0;
    for ( int i = 0 ; i < matrixLen ; ++i )
    {
        for ( int j = 0 ; j < matrixLen ; ++j )
        {
            if (secondOrderStat[i,j] > max2)
            {
                if (secondOrderStat[i,j] > max1)
                {
                    max2 = max1;
                    max1 = secondOrderStat[i,j];
                }
                else
                    max2 = secondOrderStat[i,j];
            }
        }
    }
    secondOrderStatScore = max1 + max2;
    int ThirdOrderStatScore = 0;
    for ( int n = 0 ; n < m_nts.Length-2 ; ++n )
        if (m_nts[n]==m_nts[n+1] && m_nts[n+1]==m_nts[n+2])
            ThirdOrderStatScore++;
    int first8Complexity = FirstK8Complexity();
    if (first8Complexity == 0)
        return 0;

    if (secondOrderStatScore>=10 || ThirdOrderStatScore>5)
        return 0;
    else if (secondOrderStatScore>=9)
        return (float)0.1;
    else if (secondOrderStatScore>=8)
        return (float)0.22;
    else if (secondOrderStatScore>=7)
        return (float)0.47;
    else

```

```

    return 1;
}
private int FirstK8Complexity()
{
    int k = 8;
    /*
        int[,] charArr = new int[(int)CharE.LEN,k];
        for (int i = 0; i < (int)CharE.LEN; ++i)
        {
            for (int j = 0; j < k; ++j)
            {
                charArr[i,j] = 0;
            }
        }
        for (int j = 0; j < k; ++j)
        {
            charArr[(int)CharEnum(m_nts[j]),j] = 1;
        }
    */
    int[] charCountArr = new int[(int)CharE.LEN];
    for (int i = 0; i < (int)CharE.LEN; ++i)
    {
        charCountArr[i] = 0;
    }
    int maxFlash = 0;
    int curFlash = 0;
    char curChar = 'Z';
    int maxATFlash = 0;
    int curATFlash = 0;
    for (int j = 0; j < k; ++j)
    {
        charCountArr[(int)CharEnum(m_nts[j])] += 1;
        if (curChar == m_nts[j])
        {
            ++curFlash;
        }
        else
        {
            maxFlash = Math.Max(maxFlash, curFlash);
            curChar = m_nts[j];
            curFlash = 1;
        }
        if (CharEnum(m_nts[j]) == CharE.A ||
            CharEnum(m_nts[j]) == CharE.T )
        {
            ++curATFlash;
        }
        else
        {
            maxATFlash = Math.Max(maxATFlash, curATFlash);

```

```

    curATFlash = 0;
}
}
maxFlash = Math.Max(maxFlash, curFlash);
maxATFlash = Math.Max(maxATFlash, curATFlash);
if (maxFlash >= 4)
    return 0;
if (maxATFlash >= 6)
    return 0;
int charCount = 0;
int maxCharAppear = 0;
int minCharAppear = k;
for (int i = 0; i < (int)CharE.LEN; ++i)
{
    if (charCountArr[i] > 0)
        ++charCount;
    maxCharAppear = Math.Max(maxCharAppear, charCountArr[i]);
    minCharAppear = Math.Min(minCharAppear, charCountArr[i]);
}
float wordP = (float) Math.Pow((float)charCount/4, k);
if (charCount < 3)
    return 0;
if (maxCharAppear > 6)
    return 0;
Array.Sort(charCountArr);
if (charCountArr[0] + charCountArr[1] < 2)
    return 0;
//if (minCharAppear
return 1;
}
private static CharE CharEnum(char c)
{
    if(c == 'A' || c == 'a')
        return CharE.A;
    else if (c == 'G' || c == 'g')
        return CharE.G;
    else if (c == 'T' || c == 't')
        return CharE.T;
    else if (c == 'C' || c == 'c')
        return CharE.C;
    else return CharE.LEN;
}
public float GCPercent
{
    get { return CalGCPercent(m_nts); }
}
public static float CalGCPercent(string nts)
{
    float GCCount = 0;
    if (nts == null || nts.Length == 0)

```

```

    return GCCount;
for (int i = 0; i < nts.Length; ++i)
{
    if(CharEnum(nts[i]) == CharE.G ||
        CharEnum(nts[i]) == CharE.C )
        ++GCCount;
}
return (GCCount / nts.Length);
}
public double TM
{
    get { return Nts.CalTM(m_nts); }
}
public static double CalTM(string nts)
{
    int numberOf_C=0, numberOf_T=0 , numberOf_G=0 , numberOf_A=0;
    double d_res;
    //get the numbers from nts.
    for (int i=0 ; i<nts.Length ; i++)
    {
        switch (nts[i])
        {
            case 'A':
            case 'a':
                numberOf_A ++;
                break;
            case 'C':
            case 'c':
                numberOf_C ++;
                break;
            case 'G':
            case 'g':
                numberOf_G ++;
                break;
            case 'T':
            case 't':
                numberOf_T ++;
                break;
        }
    }
    //calc TM
    d_res = 64.9 + 41*(numberOf_C + numberOf_G - 16.4) / (numberOf_A + numberOf_C + numberOf_G +
numberOf_T);
    d_res = d_res * 1.0316 + 2.2229;
    return (d_res);
}
}
using System;
using BasicTypes;

```

```

using IndexService;
using DataBaseGate;
namespace FlowManager
{
    /// <summary>
    ///
    /// </summary>
    public class MirUtrBsCal
    {
        private const int m_UTR_MIR_3_SIDE_EXT = 15; // todo SET OPTIMAL LENGTH ? NOT CONST
        private SeqsWinIndex m_utrsIndex;
        private readonly int m_windowSize;
        private const int m_SQL_CSHARP_COOR_DIFF = 1;
        public MirUtrBsCal(SeqsWinIndex utrsIndex)
        {
            m_windowSize = utrsIndex.WindowSize;
            m_utrsIndex = utrsIndex;
        }
        public BSSet CalBss(WordSeqPositions[] seqPosArr,
            int utrId, string mirSeq)
        {
            int numOfBs = 0;
            foreach (WordSeqPositions wPos in seqPosArr)
            {
                if (wPos.SeqPositions != null)
                    numOfBs += wPos.SeqPositions.Length;
            }
            BSSet bsSet = new BSSet(numOfBs);
            foreach (WordSeqPositions wPos in seqPosArr)
            {
                if (wPos.SeqPositions != null)
                {
                    CalBsForWord(bsSet, wPos, mirSeq, utrId);
                }
            }
            bsSet.Sort();
            return bsSet;
        }
        // add the bss to the bs set
        public void CalBsForWord(BSSet bsSet, WordSeqPositions wPos, string mirSeq, int utrId)
        {
            if (wPos.SeqPositions.Length > 0)
            {
                foreach (int pos in wPos.SeqPositions.Positions)
                {
                    CalBsForWordPos(bsSet, wPos.Word, pos, mirSeq, utrId);
                }
            }
        }
        // add the bs to the bs set

```

```

public void CalBsForWordPos(BSSet bsSet, MapperItem word,
int wordPos, string mirSeq, int utrId)
{
int utrSide = int.Parse(m_utrsIndex.GetAttribute(utrId,DBConsts.UTR_SIDE).ToString());
string geneName = (string) m_utrsIndex.GetAttribute(utrId,DBConsts.UTR_GENE_NAME);
string organism = (string) m_utrsIndex.GetAttribute(utrId,DBConsts.UTR_ORGANISM);
string transcriptId = (string) m_utrsIndex.GetAttribute(utrId,DBConsts.UTR_TRANSCRIPT_ID);
string externalDb = (string) m_utrsIndex.GetAttribute(utrId,DBConsts.UTR_EXTERNAL_DB);

int bsEndCoor = wordPos + m_windowSize - 1;

int alignEndCoorExt = 0;
if (word.ActionPerformed == MapperItem.Action.DELETE)
alignEndCoorExt = 2;
else if (word.ActionPerformed == MapperItem.Action.NONE ||
word.ActionPerformed == MapperItem.Action.REPLACE)
alignEndCoorExt = 1;
int alignEndCoor = alignEndCoorExt + wordPos - 1;
int alignStartCoor = alignEndCoor -
Math.Min(m_UTR_MIR_3_SIDE_EXT - 1, alignEndCoor);
// if the window was very close to the utr 5' don't do bs
if (alignEndCoor - alignStartCoor + 1 < mirSeq.Length - m_windowSize)
return;
// getting the bs align seq and reversing it
int edgeExt5 = 0;
int edgeExt3 = 0;
string bsAlignSeq = m_utrsIndex.GetSeq(utrId,alignStartCoor, alignEndCoor,ref edgeExt5, ref edgeExt3);
char[] reversedBsAlignChar = bsAlignSeq.ToCharArray();
Array.Reverse(reversedBsAlignChar);
//string reversedBsAlignSeq = new string(reversedBsAlignChar);

char[] mirAlignChar = mirSeq.ToCharArray(m_windowSize - 1,mirSeq.Length - m_windowSize + 1);
SubjectFreeEndsAlignment align =
new SubjectFreeEndsAlignment(mirAlignChar,reversedBsAlignChar);
float bsScore = CombainScoresToBsScore(word.EditScore, align.BestScore);
int bsStartCoor;
float bsPMScore;

string bsDraw = DrawAlignment(align, mirSeq, bsAlignSeq, word, alignStartCoor, alignEndCoor, out bsStartCoor, out
bsPMScore);
string bsSeq = bsAlignSeq.Substring(bsStartCoor - alignStartCoor) +
word.WordStr(MirUtrBsPvalCal.UTR_INDEX_WINDOW_SIZE).Substring(alignEndCoorExt);
int bsPosition = bsStartCoor;
BS bs = new BS(utrId, utrSide,geneName,organism,transcriptId,externalDb, bsSeq,mirSeq,
bsPosition + m_SQL_CSHARP_COOR_DIFF,bsScore,bsPMScore,word.EditScore,align.BestScore, bsDraw);
bsSet.Add(bs);
}

private float CombainScoresToBsScore(float wordScore, float alignScore)
{

```

```

float calAlignScore = 0, calWordScore = 0;
if (alignScore < 5)
    calAlignScore = 1;
else if (alignScore < 6)
    calAlignScore = 3;
else if (alignScore < 7)
    calAlignScore = 30;
else
    calAlignScore = 1000;

if (wordScore == 2)
    calWordScore = 1;
if (wordScore == 1)
    calWordScore = 10;
if (wordScore == 0)
    calWordScore = 100;
return calWordScore * calAlignScore;
}

private string DrawAlignment(SubjectFreeEndsAlignment align,
    string mirseq, string bsAlignSeq,
    MapperItem word,
    int alignStartUtrCoor, int alignEndUtrCoor,
    out int bsStartCoor,
    out float bsPMScore)
{
    // the align start and end can be the same
    int alignStartCoor;
    int alignEndCoor;
    char[,] alignChar =
        align.GetOneOfTheBestTrackBacksCharArr(out alignStartCoor,
            out alignEndCoor);
    bsStartCoor = alignStartUtrCoor + (bsAlignSeq.Length - 1 - alignEndCoor);
    char[,] wordAlignChar =
        AlignWord(word, mirseq);
    bsPMScore = CalPMScore(wordAlignChar, alignChar);
    char[] aligndraw = new char[(wordAlignChar.Length + alignChar.Length) + 3];
    int h = 0;
    // going from the ends
    for (int i = 0; i < 4; ++i)
    {
        for (int j = 0; j < wordAlignChar.Length/4 + alignChar.Length/4; ++j)
        {
            // pasrt of the align
            if (j < alignChar.Length/4)
            {
                aligndraw[h] = alignChar[alignChar.Length/4 - 1 - j, i];
                ++h;
            } // part of the word align
            else
            {

```

```

        aligndraw[h] = wordAlignChar[wordAlignChar.Length/4 - 1 - (j - alignChar.Length/4), i];
        ++h;
    }
}
if (i < 3)
{
    aligndraw[h] = '\n';
    ++h;
}
}
return new string(aligndraw);
}
private float CalPMScore(char[,] wordAlignChar, char[,] alignChar)
{
    float alignLength = wordAlignChar.Length/4 + alignChar.Length/4;
    float matchCounter = 0;
    for (int i = 0; i < wordAlignChar.Length/4; ++ i)
    {
        if (IsMatch(wordAlignChar, i))
            ++matchCounter;
    }
    for (int i = 0; i < alignChar.Length/4; ++ i)
    {
        if (IsMatch(alignChar, i))
            ++matchCounter;
    }
    return matchCounter / alignLength;
}

private bool IsMatch(char[,] alignChar, int index)
{
    return (
        ( alignChar[index,1] == 'A' || alignChar[index,1] == 'a') &&
        (alignChar[index,2] == 'T' || alignChar[index,2] == 't') ) ||
        ( alignChar[index,1] == 'T' || alignChar[index,1] == 't') &&
        (alignChar[index,2] == 'A' || alignChar[index,2] == 'a') ) ||
        ( alignChar[index,1] == 'C' || alignChar[index,1] == 'c') &&
        (alignChar[index,2] == 'G' || alignChar[index,2] == 'g') ) ||
        ( alignChar[index,1] == 'G' || alignChar[index,1] == 'g') &&
        (alignChar[index,2] == 'C' || alignChar[index,2] == 'c') )
    );
}

public char[,] AlignWord(MapperItem word, string mirseq)
{
    string wordStr = word.WordStr(MirUtrBsPvalCal.UTR_INDEX_WINDOW_SIZE);
    char[] wordAlignChar = null;
    char[,] alignChar;

    if (word.ActionPerformed == MapperItem.Action.DELETE)
    {

```

```

wordAlignChar = wordStr.ToCharArray(2,m_windowSize - 2);
alignChar = new char[m_windowSize - 1,4];
}
else if (word.ActionPerformed == MapperItem.Action.NONE ||
word.ActionPerformed == MapperItem.Action.REPLACE)
{
wordAlignChar = wordStr.ToCharArray(1,m_windowSize - 1);
alignChar = new char[m_windowSize - 1,4];
}
else
{
wordAlignChar = wordStr.ToCharArray(0,m_windowSize);
alignChar = new char[m_windowSize,4];
}
// reversing the word
Array.Reverse(wordAlignChar);
int mirIndex = 0;
int wordIndex = 0;
for (int outputIndex = 0; outputIndex < alignChar.Length/4 ; ++outputIndex)
{
if (mirIndex >= m_windowSize - 1 || wordIndex >= wordAlignChar.Length)
throw new ArgumentException("mir or word out of bound: " + mirIndex + "," + wordIndex);
if (outputIndex == word.ActionPosition)
{
if (word.ActionPerformed == MapperItem.Action.INSERT)
{
SubjectFreeEndsAlignment.PaintQueryGap(alignChar,outputIndex,wordAlignChar[wordIndex]);
++wordIndex;
}
else if(word.ActionPerformed == MapperItem.Action.REPLACE)
{
SubjectFreeEndsAlignment.PaintMisMatch(alignChar,outputIndex,mirseq[mirIndex],wordAlignChar[wordIndex]);
++mirIndex;
++wordIndex;
}
else if (word.ActionPerformed == MapperItem.Action.DELETE)
{
SubjectFreeEndsAlignment.PaintSubjectGap(alignChar,outputIndex,mirseq[mirIndex]);
++mirIndex;
}
else
throw new ArgumentException(" unknown kind of action preformed in word item");
}
else
{
SubjectFreeEndsAlignment.PaintMatch(alignChar,outputIndex,mirseq[mirIndex],wordAlignChar[wordIndex]);
++mirIndex;
++wordIndex;
}
}
}

```

```

    return alignChar;
}
// -1 no pos left in the array
private int MinPosIndex(int[] seqPosIndexPosArr, SeqPositions[] seqPosArr)
{
    int returnedIndex = -1;
    for (int i = 0; i < seqPosArr.Length; ++i)
    {
        if (seqPosIndexPosArr[i] > 0 && seqPosIndexPosArr[i] < seqPosArr[i].Length)
        {
            if (returnedIndex == -1)
                returnedIndex = seqPosArr[i][seqPosIndexPosArr[i]];
            else
                returnedIndex = Math.Min(returnedIndex, seqPosArr[i][seqPosIndexPosArr[i]]);
        }
    }
    return returnedIndex;
}
public static int UTR_MIR_3_SIDE_EXT
{
    get { return m_UTR_MIR_3_SIDE_EXT; }
}
}
using System;
using System.Text;
using System.IO;
using System.Runtime.Serialization;
using System.Runtime.Serialization.Formatters.Binary;
using IndexService;
using BasicTypes;
using GPLogging;

namespace FlowManager
{
    /// <summary>
    /// Summary description for UtrBsPvalCal.
    /// </summary>
    [Serializable]
    public class MirUtrBsPvalCal
    {
        private const int UTR_INDEX_WIN_SIZE = 9;
        private const int m_PM_START = 0;
        private const int SCR_TH_NUM = 5;
        private const int MAX_BS_NUM = 7;
        private const int MIN_BS_DIST = 20;
        private const int MAX_CLOSE_BS_DIST = 100;
        private static readonly int[] SCR_TH = new int[] {3,10,30,100,1000};

        private float[,] m_pvalMatrix = new float[(int)MAX_BS_NUM,(int)SCR_TH_NUM];

```

```

private float[,] m_pvalMatrixWithCloseBS = new float[(int)MAX_BS_NUM,(int)SCR_TH_NUM];
private const string m_IN_TBL_TAB = "|";
private const string m_BETWEEN_TBL_TAB = "^";
public MirUtrBsPvalCal(string[] mirs, SeqsWinIndex utrsIndex, int utrId, WordEditMapper wordMap)
{
    for (int i = 0 ; i < MAX_BS_NUM ; ++i)
    {
        for (int j = 0 ; j < SCR_TH_NUM ; ++j)
        {
            m_pvalMatrix[i,j] = 0;
        }
    }

    BSSet bsSet;
    MirUtrBsCal bsCal = new MirUtrBsCal(utrsIndex);
    int lastInsertOffset;
    int bsNum = 1;
    bool closeBsFlag;
    WordSeqPositions[] spArr;
    for (int i = 0 ; i<mirs.Length ; ++i)
    {

        spArr = MirBsFinder.CalMirUtrSeqPositions(utrsIndex,wordMap,utrId,mirs[i]);
        bsSet = bsCal.CalBss(spArr,utrId,mirs[i]);
        for (int j = 0 ; j < SCR_TH_NUM ; ++j)
        {
            lastInsertOffset = -MAX_CLOSE_BS_DIST;
            bsNum = 0;
            closeBsFlag = false;
            for (int cnt=0 ; cnt < bsSet.Count ; ++cnt)
            {
                if (bsSet[cnt].UtrPosition - lastInsertOffset >= MIN_BS_DIST &&
                    bsSet[cnt].BSScore >= SCR_TH[j])
                {
                    if (bsSet[cnt].UtrPosition - lastInsertOffset < MAX_CLOSE_BS_DIST)
                        closeBsFlag = true;
                    lastInsertOffset = bsSet[cnt].UtrPosition;
                    bsNum++;
                }
            }
            for (int m = 0 ; m <= bsNum && m < MAX_BS_NUM ; ++m)
            {
                if (m < bsNum)
                {
                    m_pvalMatrix[m,j]++;
                    if (closeBsFlag)
                        m_pvalMatrixWithCloseBS[m,j]++;
                }
            }
            else
            {

```

```

        m_pvalMatrix[m,j] = m_pvalMatrix[m,j] + (float)0.5;
        if (closeBsFlag)
            m_pvalMatrixWithCloseBS[m,j] = m_pvalMatrixWithCloseBS[m,j] + (float)0.5;
    }
}
}
}
for (int i = 0 ; i < MAX_BS_NUM ; ++i)
{
    for (int j = 0 ; j < SCR_TH_NUM ; ++j)
    {
        m_pvalMatrix[i,j] /= mirs.Length;
        m_pvalMatrixWithCloseBS[i,j] /= mirs.Length;
    }
}
}
public override string ToString()
{
    StringBuilder returnedString = new StringBuilder((SCR_TH_NUM * MAX_BS_NUM * 2 * 6) + 200);
    for ( int i = 0; i < MAX_BS_NUM; ++i)
    {
        for ( int j = 0; j < SCR_TH_NUM; ++j)
        {
            returnedString.Append(m_pvalMatrix[i,j].ToString());
            returnedString.Append(m_IN_TBL_TAB);
        }
    }
    returnedString.Append(m_BETWEEN_TBL_TAB);
    for ( int i = 0; i < MAX_BS_NUM; ++i)
    {
        for ( int j = 0; j < SCR_TH_NUM; ++j)
        {
            returnedString.Append(m_pvalMatrixWithCloseBS[i,j].ToString());
            returnedString.Append(m_IN_TBL_TAB);
        }
    }
    // putting the parameters
    // UTR_INDEX_WIN_SIZE
    returnedString.Append(m_BETWEEN_TBL_TAB + UTR_INDEX_WIN_SIZE.ToString());
    // m_PM_START
    returnedString.Append(m_IN_TBL_TAB + m_PM_START.ToString());
    // SCR_TH_NUM
    returnedString.Append(m_IN_TBL_TAB + SCR_TH_NUM.ToString());
    // MAX_BS_NUM
    returnedString.Append(m_IN_TBL_TAB + MAX_BS_NUM.ToString());
    // MIN_BS_DIST
    returnedString.Append(m_IN_TBL_TAB + MIN_BS_DIST.ToString());
    // MAX_CLOSE_BS_DIST
    returnedString.Append(m_IN_TBL_TAB + MAX_CLOSE_BS_DIST.ToString());
    // SCR_TH array

```

```

        returnedString.Append(m_BETWEEN_TBL_TAB);
        for (int i = 0; i < SCR_TH.Length ; ++i)
        {
            returnedString.Append(SCR_TH[i].ToString() + m_IN_TBL_TAB);
        }
        return returnedString.ToString();
    }

    /*
    BinaryFormatter formatter = new BinaryFormatter();
    MemoryStream stream = new MemoryStream();
    formatter.Serialize(stream, this);
    byte[] byteArray = new byte[stream.Length];
    stream.Seek(0, SeekOrigin.Begin);
    stream.Read(byteArray, 0, (int)stream.Length);
    stream.Close();
    UnicodeEncoding encoding = new UnicodeEncoding();
    return encoding.GetString(byteArray);
    */
}

// for FromString(string repStr) only
private MirUtrBsPvalCal()
{}

public static MirUtrBsPvalCal FromString(string repStr)
{
    MirUtrBsPvalCal returnedPvalCal = new MirUtrBsPvalCal();
    if (repStr == null || repStr == "")
        return null ;
    string[] matrixStrArr = repStr.Split(m_BETWEEN_TBL_TAB[0]);
    string[] pvalMatrixStr = matrixStrArr[0].Split(m_IN_TBL_TAB[0]);
    string[] pvalMatrixWithCloseBSStr = matrixStrArr[1].Split(m_IN_TBL_TAB[0]);
    int matrixStrIndex = 0;
    for ( int i = 0; i < MAX_BS_NUM; ++i)
    {
        for ( int j = 0; j < SCR_TH_NUM; ++j)
        {
            returnedPvalCal.m_pvalMatrix[i,j] = float.Parse(pvalMatrixStr[matrixStrIndex]);
            returnedPvalCal.m_pvalMatrixWithCloseBS[i,j] = float.Parse(pvalMatrixWithCloseBSStr[matrixStrIndex]);
            ++matrixStrIndex;
        }
    }

    // checking the version
    // two matrix const and thresh array
    if (matrixStrArr.Length < 4)
    {
        GPLogger.Instance.Error("From string: different PvalCal versions (main array length)");
        return null;
    }
    string[] constArr = matrixStrArr[2].Split(m_IN_TBL_TAB[0]);
    string[] threshArr = matrixStrArr[3].Split(m_IN_TBL_TAB[0]);
    if (constArr.Length < 6)
    {

```

```

GPLogger.Instance.Error("From string: different PvalCal versions (const array length)");
return null;
}
if ( (int.Parse(constArr[0]) != UTR_INDEX_WIN_SIZE) ||
(int.Parse(constArr[1]) != m_PM_START) ||
(int.Parse(constArr[2]) != SCR_TH_NUM) ||
(int.Parse(constArr[3]) != MAX_BS_NUM) ||
(int.Parse(constArr[4]) != MIN_BS_DIST) ||
(int.Parse(constArr[5]) != MAX_CLOSE_BS_DIST) )
{
GPLogger.Instance.Error("From string: different PvalCal versions (different consts");
return null;
}
if (threshArr.Length < SCR_TH.Length)
{
GPLogger.Instance.Error("From string: different PvalCal versions (thresh array length)");
return null;
}
for (int i = 0; i < SCR_TH.Length ; ++i)
{
if ( (int.Parse(threshArr[i]) != SCR_TH[i]) )
{
GPLogger.Instance.Error("From string: different PvalCal versions (threshArr array values)");
return null;
}
}
return returnedPvalCal;
}
/*
public static MirUtrBsPvalCal FromString(string serializationStr)
{
if (serializationStr == null || serializationStr == "")
return null;
else
{
try
{
UnicodeEncoding encoding = new UnicodeEncoding();

byte[] byteArray = encoding.GetBytes(serializationStr.ToString());

BinaryFormatter formatter = new BinaryFormatter();
MemoryStream stream = new MemoryStream();
stream.Seek(0, SeekOrigin.Begin);
stream.Write(byteArray, 0, byteArray.Length);
stream.Seek(0, SeekOrigin.Begin);
MirUtrBsPvalCal strMirUtrBsPvalCal =
(MirUtrBsPvalCal)formatter.Deserialize(stream);
stream.Close();
return strMirUtrBsPvalCal;
}
}
}

```

```

    }
    catch(Exception ex)
    {
        GPLogger.Instance.Error(ex);
        throw ex;
    }
}
}
*/

//UTR_INDEX_WIN_SIZE
public static int UTR_INDEX_WINDOW_SIZE
{
    get {return UTR_INDEX_WIN_SIZE;}
}

public static int PM_START
{
    get {return m_PM_START;}
}

// update the threshold, the pVal, and the used for pVal cal
public void CalPval(BSSet bsSet)
{
    float pVal = 1;
    float thresh = SCR_TH[0];
    int lastInsertOffset;
    int bsNum = 1;
    bool closeBsFlag;
    float tmpPval;

    for (int i=0 ; i < SCR_TH_NUM && bsNum > 0 ; ++i)
    {
        lastInsertOffset = -MAX_CLOSE_BS_DIST;
        bsNum = 0;
        closeBsFlag = false;
        for (int cnt=0 ; cnt < bsSet.Count ; ++cnt)
        {
            if (bsSet[cnt].UtrPosition-lastInsertOffset >= MIN_BS_DIST &&
                bsSet[cnt].BSScore >= SCR_TH[i])
            {
                if (bsSet[cnt].UtrPosition - lastInsertOffset < MAX_CLOSE_BS_DIST)
                    closeBsFlag = true;
                lastInsertOffset = bsSet[cnt].UtrPosition;
                bsNum++;
            }
        }
        if (bsNum >= MAX_BS_NUM)
            bsNum = MAX_BS_NUM - 1;
        if (closeBsFlag)
            tmpPval = 1 - (float)Math.Pow(1 - m_pvalMatrixWithCloseBS[bsNum,i], i + 1);
        else

```

```

    tmpPval = 1 - (float)Math.Pow(1 - m_pvalMatrix[bsNum,i], i + 1);
    if (tmpPval < pVal)
    {
        pVal = tmpPval;
        thresh = SCR_TH[i];
    }
}
lastInsertOffset = -MAX_CLOSE_BS_DIST;
for (int cnt=0 ; cnt < bsSet.Count ; ++cnt)
{
    bsSet[cnt].UtrThresh = thresh;
    bsSet[cnt].UtrPval = pVal;
    if (bsSet[cnt].UtrPosition - lastInsertOffset >= MIN_BS_DIST &&
        bsSet[cnt].BSScore >= thresh)
    {
        lastInsertOffset = bsSet[cnt].UtrPosition;
        bsSet[cnt].UsedForPValCal = true;
    }
    else
        bsSet[cnt].UsedForPValCal = false;
}
}
}
}
using System;
namespace IndexService
{
    /// <summary>
    /// Summary description for AlignmentDetails.
    /// </summary>
    public class AlignmentDetails
    {
        /// <summary>
        /// Summary description for OffsetScore.
        /// </summary>

        int m_offset;
        int m_score;
        int m_bsSubjLen;
        bool m_usedForPval = false;
        public AlignmentDetails(int offset, int score, int bsSubjLen)
        {
            m_offset = offset;
            m_score = score;
            m_bsSubjLen = bsSubjLen;
        }
        public int Offset
        {
            get
            {

```

```

        return m_offset;
    }
    set
    {
        m_offset = value;
    }
}
public int Score
{
    get
    {
        return m_score;
    }
    set
    {
        m_score = value;
    }
}
public int BsSubjLen
{
    get
    {
        return m_bsSubjLen;
    }
    set
    {
        m_bsSubjLen = value;
    }
}
public bool UsedForPval
{
    get
    {
        return m_usedForPval;
    }
    set
    {
        m_usedForPval = value;
    }
}
}
}
using System;
using System.Collections;
namespace IndexService
{
    /// <summary>
    ///
    /// </summary>

```

```

public class AlignmentEntry
{
    int m_score = 0;
    char[] m_subjectChar;
    char[] m_queryChar;
    int m_subjectCoor;
    int m_queryCoor;
    BitArray m_subjectStartArray;
    AlignmentEntry[] m_prevArray;
    // gap extension parameters
    int m_queryLeftToSubjectScore;
    int m_subjectLeftToQueryScore;
    int m_subjectToQueryScore;
    bool m_isMatch = false;
    public enum PrevDirection {LEFT,DIAGONAL,UP};
    public AlignmentEntry(char[] subjectChar, char[] queryChar, int subjectCoor,int queryCoor, AlignmentEntry[]
prevArray)
    {
        if (subjectChar == null || queryChar == null)
            throw new ArgumentException("query or subject char null");
        m_subjectChar = subjectChar;
        m_queryChar = queryChar;
        m_subjectCoor = subjectCoor;
        m_queryCoor = queryCoor;
        m_subjectStartArray = new BitArray(Math.Max(subjectCoor + 1,0),false);
        m_prevArray = prevArray;
        if (prevArray.Length != 3)
            throw new ArgumentException("not all prev given");
    }
    public int SubjectCoor
    {
        get
        {
            return m_subjectCoor;
        }
    }
    public int QueryCoor
    {
        get
        {
            return m_queryCoor;
        }
    }
    public int Score
    {
        get
        {
            return m_score;
        }
        set
    }

```

```

{
    m_score = value;
}
}
public int SubjectToQueryScore
{
    get
    {
        return m_subjectToQueryScore;
    }
    set
    {
        m_subjectToQueryScore = value;
    }
}
public int SubjectLeftToQueryScore
{
    get
    {
        return m_subjectLeftToQueryScore;
    }
    set
    {
        m_subjectLeftToQueryScore = value;
    }
}
public int QueryLeftToSubjectScore
{
    get
    {
        return m_queryLeftToSubjectScore;
    }
    set
    {
        m_queryLeftToSubjectScore = value;
    }
}
public AlignmentEntry[] PrevArray
{
    get
    {
        return m_prevArray;
    }
    set
    {
        m_prevArray = value;
    }
}
public BitArray SubjectStartArray
{

```

```

get
{
    return m_subjectStartArray;
}
set
{
    m_subjectStartArray = value;
}
}
private void AddSubjectStart(BitArray subStartArr)
{
    int minLen = Math.Min(subStartArr.Length, m_subjectStartArray.Length);
    for (int i = 0; i < minLen; ++i)
    {
        m_subjectStartArray[i] = m_subjectStartArray[i] || subStartArr[i];
    }
}
public bool IsMismatch
{
    get
    {
        return !m_isMatch;
    }
}
public bool IsMatch
{
    get
    {
        return m_isMatch;
    }
}
public AlignmentEntry UpEntry
{
    get
    {
        return m_prevArray[(int)PrevDirection.UP];
    }
}
public AlignmentEntry LeftEntry
{
    get
    {
        return m_prevArray[(int)PrevDirection.LEFT];
    }
}
public AlignmentEntry DiagonalEntry
{
    get
    {
        return m_prevArray[(int)PrevDirection.DIAGONAL];
    }
}

```

```

}
}
/*
public bool IsSubjectInsertion()
{
    // TODO
    return true;
}
public bool IsQueryInsertion()
{
    // TODO
    return true;
}
*/
public void CalAlignment(AlignmentParams alignParams)
{
    if (m_queryCoor == -1)
        CalAlignmentLeftEndSubject(alignParams);
    else if (m_subjectCoor == -1)
        CalAlignmentLeftEndQuery(alignParams);
    else
    {
        if (alignParams.IsMatch(m_queryChar[m_queryCoor], m_subjectChar[m_subjectCoor]))
            m_isMatch = true;
        int matchCost =
alignParams.MatchScore(m_queryCoor, m_subjectCoor, m_queryChar.Length, m_queryChar[m_queryCoor], m_subject
Char[m_subjectCoor]);
        m_queryLeftToSubjectScore =
            Math.Max(m_prevArray[(int)PrevDirection.LEFT].Score +
alignParams.SubjectGapOpen(m_queryCoor, m_subjectCoor, m_queryChar.Length),
            m_prevArray[(int)PrevDirection.LEFT].QueryLeftToSubjectScore) +
alignParams.SubjectGapExt(m_queryCoor, m_subjectCoor, m_queryChar.Length);
        m_subjectLeftToQueryScore =
            Math.Max(m_prevArray[(int)PrevDirection.UP].Score + alignParams.QueryGapOpen(m_queryCoor, m_subjectCoor,
m_queryChar.Length),
            m_prevArray[(int)PrevDirection.UP].SubjectLeftToQueryScore) +
alignParams.QueryGapExt(m_queryCoor, m_subjectCoor, m_queryChar.Length);
        m_subjectToQueryScore = matchCost + m_prevArray[(int)PrevDirection.DIAGONAL].Score;
        m_score =
Math.Max(Math.Max(m_queryLeftToSubjectScore, m_subjectLeftToQueryScore), m_subjectToQueryScore);
        // 24.4.04 bug fix the query can start with a gap
        // so the end and start coordinate of the subject can be the same coordinate
        if ( (m_score == m_subjectToQueryScore ||
            m_score == m_subjectLeftToQueryScore) && m_queryCoor == 0)
            m_subjectStartArray[m_subjectCoor] = true;
        if (m_subjectCoor == 0)
            m_subjectStartArray[m_subjectCoor] = true;
        UpdateAlignTrack(PrevDirection.UP, m_subjectLeftToQueryScore);
        UpdateAlignTrack(PrevDirection.LEFT, m_queryLeftToSubjectScore);
        UpdateAlignTrack(PrevDirection.DIAGONAL, m_subjectToQueryScore);
    }
}

```

```

    }
}
private void UpdateAlignTrack(PrevDirection side, int score)
{
    if (score == m_score)
    {
        AddSubjectStart(m_prevArray[(int)side].SubjectStartArray);
    }
    else
    {
        m_prevArray[(int)side] = null;
    }
}
public void CalAlignmentLeftEndSubject(AlignmentParams alignParams)
{
    if (m_subjectCoor == -1)
    {
        m_score = 0;

    }
    else if (m_subjectCoor == 0)
    {
        m_score = m_prevArray[(int)PrevDirection.LEFT].Score +
            alignParams.SubjectGapOpen(m_queryCoor, m_subjectCoor, m_queryChar.Length) +
            alignParams.SubjectGapExt(m_queryCoor, m_subjectCoor, m_queryChar.Length);
    }
    else
    {
        m_score = m_prevArray[(int)PrevDirection.LEFT].Score +
            alignParams.SubjectGapExt(m_queryCoor, m_subjectCoor, m_queryChar.Length);
    }
    m_queryLeftToSubjectScore = m_score;
    m_subjectLeftToQueryScore = m_score;
    m_subjectToQueryScore = m_score;
    m_isMatch = false;
}
public void CalAlignmentLeftEndQuery(AlignmentParams alignParams)
{
    if (m_queryCoor == -1)
    {
        m_score = 0;
    }
    else if (m_queryCoor == -1)
    {
        m_score = m_prevArray[(int)PrevDirection.UP].Score +
            alignParams.QueryGapOpen(m_queryCoor, m_subjectCoor, m_queryChar.Length) +
            alignParams.QueryGapExt(m_queryCoor, m_subjectCoor, m_queryChar.Length);
    }
    else

```

```

{
    m_score = m_prevArray[(int)PrevDirection.UP].Score +
        alignParams.QueryGapExt(m_queryCoor,m_subjectCoor, m_queryChar.Length);
}
m_queryLeftToSubjectScore = m_score;
m_subjectLeftToQueryScore = m_score;
m_subjectToQueryScore = m_score;
m_isMatch = false;
}
public int SubjectStartNum
{
    get
    {
        if (m_subjectStartArray.Length == 0)
            return 0;
        int count = 0;
        for (int i = 0; i < m_subjectStartArray.Length; ++i)
        {
            if (m_subjectStartArray[i])
                ++count;
        }
        return count;
    }
}
}
using System;
namespace IndexService
{
    /// <summary>
    ///
    /// </summary>
    public class AlignmentFinder
    {
        public AlignmentFinder()
        {
            //
            // TODO: Add constructor logic here
            //
        }

        public static double string_similarity(string s,string t)//, double[] p)
        {

            // const int RESF =1; // right end spaces are free (not penalized)
            const int LESF=0; // left end spaces are free (not penalized)
            double res;
            int k,i,j,n,m;
            float max1, cost;//,*V, *H, *E,*F;
            //int R, Mcg, Mat,Mgt, S, G; //replace , match(for each pairing) , gap extend, gap-open,

```

```

int R = 2;//(float) p[0];
int Mcg =3;// (float) p[1];
int Mat =3;// (float) p[2];
int Mgt =1;// (float) p[3];
int S =2;// (float) p[4];
int G =6;// (float) p[5];

```

```

n=s.Length;
m=t.Length;
if(n!=0 && m!=0)
{
    float[] V=new float[(m+1)*(n+1)];
    float[] E=new float[(m+1)*(n+1)];
    float[] F=new float[(m+1)*(n+1)];
    float[] H=new float[(m+1)*(n+1)];

```

```

    m++;
    n++;
    //Step 2
    if (LESF == 0)
    {
        for(k=0;k<n;k++)
        {
            V[k]=-G-S*k;
            E[k]=-G-S*k;
        }
        for(k=0;k<m;k++)
        {
            V[k*n]=-G-S*k;
            F[k*n]=-G-S*k;
        }
    } /*

```

```

else
{
    for(k=0;k<n;k++)
    {
        V[k]=-G-S*k;
        E[k]=0;
    }
    for(k=0;k<m;k++)
    {
        V[k*n]=-G-S*k;
        F[k*n]=0;
    }
}*/

```

```

//Step 3 and 4
for(i=1;i<n;i++)
{
    for(j=1;j<m;j++)
    {

```

```

//Step 5
cost = -R;
if (((s[i-1]== 'A') & (t[j-1]== 'T')) | ((s[i-1]== 'T') & (t[j-1]== 'A'))))
    cost = Mat;
if (((s[i-1]== 'C') & (t[j-1]== 'G')) | ((s[i-1]== 'G') & (t[j-1]== 'C'))))
    cost = Mcg;
if (((s[i-1]== 'G') & (t[j-1]== 'T')) | ((s[i-1]== 'T') & (t[j-1]== 'G'))))
    cost = Mgt;

H[j*n+i] = V[(j-1)*n+i-1] + cost;

max1 = Math.Max(E[(j-1)*n+i], (V[(j-1)*n+i]-G));
E[j*n+i] = max1 - S;
max1 = Math.Max(F[j*n+i-1], (V[j*n+i-1]-G)) ;
F[j*n+i] = max1 - S;
max1 = Math.Max(E[j*n+i], F[j*n+i]);
V[j*n+i]= Math.Max(max1, H[j*n+i]);
//mexPrintf("%d %d    %2.0f %2.0f %2.0f %2.0f \n", i, j, H[j*n+i],E[j*n+i],F[j*n+i],V[j*n+i]);
}
}

```

```

/* if (RESF == 0)
    res=V[n*m-1];
else
{
    max1 = V[n-1];
    for (j = 1; j < m; j++)
    {
        max1 = Math.Max(max1, V[n*j+n-1]);
    }
    for (i = 0; i < n; i++)
    {
        max1 = Math.Max(max1, V[n*(m-1)+i]);
    }
    res = max1;
}*/
max1 = V[n-1];
for (j = 1; j < m; j++)
{
    max1 = Math.Max(max1, V[n*j+n-1]);
}
for (i = 0; i < n; i++)
{
    max1 = Math.Max(max1, V[n*(m-1)+i]);
}
res = max1;

}
else

```

```

    res=-999.99; //this return value means that one or both strings are empty.
    return res;
}

public static int levenshtein_distance(char[] s,char[] t)
//Compute levenshtein distance between s and t
{
    //Step 1
    int cost;
    int[] d;
    int min1;
    int n= s.Length;
    int m= t.Length;
    if(n == 0 || m == 0)
        throw new ArgumentException("levenshtein_distance got empty array");

    d = new int[(m+1)*(n+1)];
    //d=(int *) malloc((sizeof(int))*(m+1)*(n+1));
    m++;
    n++;
    //Step 2 init the edges of the matrix
    for(int k = 0; k < n ; k++)
        d[k]= k;
    for(int k = 0; k < m; k++)
        d[k*n]=k;
    //Step 3 and 4 filling the matrix
    for(int i = 1 ; i < n ; i++)
    {
        for(int j = 1 ; j < m ; j++)
        {
            //Step 5
            cost = (s[i-1]==t[j-1])? 0 : 1;
            //Step 6
            min1 =
                (d[(j-1)* n + i] < d[ j * n + (i - 1) ]) ?
                d[(j-1)*n+i] + 1 : d[j*n+i-1] + 1;
            d[ (j * n) + i]=
                (min1 < d[(j-1)*n+i-1]+cost) ?
                min1 : d[(j-1)*n+i-1] + cost;
        }
    }
    return d[ (n * m) - 1];
}

public static int EdistFreeSubjectEnds(char[] subject,char[] query)
//Compute levenshtein distance between subject and t
{
    //Step 1
    int cost;
    int[] d;
    int min1;
    if (subject == null || query == null)

```

```

        throw new ArgumentException("EdistFreeSubjectEnds got null array");
int n = subject.Length + 1;
int m = query.Length + 1;
if(n == 0 || m == 0)
    throw new ArgumentException("levenshtein_distance got empty array");

d = new int[m*n];
//Step 2 init the edges of the matrix
// the subject has free ends
for(int k = 0; k < n ; ++k)
    d[k]= 0;
for(int k = 0; k < m; ++k)
    d[k*n]=k;
//Step 3 and 4 filling the matrix
for(int i = 1 ; i < n ; ++i)
{
    for(int j = 1 ; j < m ; ++j)
    {
        //Step 5
        cost = (subject[i-1]==query[j-1])? 0 : 1;
        //Step 6
        min1 =
            (d[(j-1)* n + i] < d[ j * n + (i - 1) ]) ?
            d[(j-1)*n+i] + 1 : d[j*n+i-1] + 1;
        d[ (j * n) + i]=
            (min1 < d[(j-1)*n + i-1] + cost) ?
            min1 : d[(j-1)*n + i-1] + cost;
    }
}
int returnCost = d[n * (m - 1)];

for (int j = 1 ; j < n ; ++j)
{
    returnCost = Math.Min(returnCost, d[n * (m - 1) + j]);
}
return returnCost;
}

}

using System;
using GPLogging;
namespace IndexService
{
    /// <summary>
    ///
    /// </summary>
    public class AlignmentParams
    {
        public enum CharE {A,G,T,C,LEN,N,Z};

```

```

private int[,] m_matchMatrix = new int[(int)CharE.LEN,(int)CharE.LEN];
private int m_queryGapOpen;
private int m_queryGapExt;
private int m_subjectGapOpen;
private int m_subjectGapExt;
private int m_misMatchOpen = 0;
private bool[] m_queryCenterBulge;
private int m_qcb_match;
private int m_qcb_queryGapOpen;
private int m_qcb_queryGapExt;
private int m_qcb_subjectGapOpen;
private int m_qcb_subjectGapExt;
private int m_qcb_misMatchOpen = 0;
// handling perfectMatch
private int m_queryPerfectMatchStart = 0;
private int m_subjectPerfectMatchStart = 0;
private int m_perfectMatchLen = 0;
private int m_perfectMatchPunishment;
private int m_NcharMatchPunishment;
private const int m_PUNISHMENT_K = -1;
public AlignmentParams(int queryLen) : this(queryLen,0,0,0)
{}
public AlignmentParams(int queryLen,
    int queryStartPerfectMatch,
    int subjectStartPerfectMatch,
    int perfectMatchLen)
{
    if (queryLen <= 0)
        throw new ArgumentException("query len non positive:" + queryLen);
    m_queryGapOpen = 0;
    m_queryGapExt = 0;
    m_subjectGapOpen = 0;
    m_subjectGapExt = -1;
    InitMatrix();
    m_queryCenterBulge = new bool[queryLen];
    int i;
    for (i = 0 ; i < queryLen-9 ; ++i)
        m_queryCenterBulge[i] = true;
    for ( ; i < queryLen-2 ; ++i)
        m_queryCenterBulge[i] = false;
    for ( ; i < queryLen ; ++i)
        m_queryCenterBulge[i] = true;
    m_qcb_match = 0;
    m_qcb_queryGapOpen = 0;
    m_qcb_queryGapExt = 0;
    m_qcb_subjectGapOpen = 0;
    m_qcb_subjectGapExt = 0;
    // perfect match
    m_queryPerfectMatchStart = queryStartPerfectMatch;
    m_subjectPerfectMatchStart = subjectStartPerfectMatch;

```

```

m_perfectMatchLen = perfectMatchLen;
// make sure the perfect
m_perfectMatchPunishment = m_PUNISHMENT_K * 2 * queryLen;
m_NcharMatchPunishment = m_PUNISHMENT_K * 2 * queryLen;
}
public bool IsPartOfPerfectMatch(int queryCoor)
{
    if (m_perfectMatchLen == 0)
        return false;
    else if (queryCoor >= m_queryPerfectMatchStart &&
        queryCoor < m_queryPerfectMatchStart + m_perfectMatchLen)
        return true;
    else
        return false;
}
private void InitMatrix()
{
    int matrixLen = (int) CharE.LEN;
    for (int i = 0; i < matrixLen; ++i)
    {
        for (int j = 0; j < matrixLen; ++j)
        {
            m_matchMatrix[i,j] = 0;
        }
    }
    m_matchMatrix[(int)CharE.A,(int)CharE.T] = 1;
    m_matchMatrix[(int)CharE.T,(int)CharE.A] = 1;
    m_matchMatrix[(int)CharE.G,(int)CharE.C] = 1;
    m_matchMatrix[(int)CharE.C,(int)CharE.G] = 1;
    //m_matchMatrix[(int)CharE.G,(int)CharE.T] = -1;
    //m_matchMatrix[(int)CharE.T,(int)CharE.G] = -1;
}
public int MatchScore(int queryCoor, int subjCoor, int queryLen,
    char queryNt,char subjectNt)
{
    int queryNtEnumInt = (int)CharEnum(queryNt);
    int subjectNtEnumInt = (int)CharEnum(subjectNt);
    if (queryNtEnumInt == (int) CharE.N || subjectNtEnumInt == (int) CharE.N)
        return m_NcharMatchPunishment;
    if(IsPartOfPerfectMatch(queryCoor))
    {
        if (!IsMatch(queryNt, subjectNt))
            return m_perfectMatchPunishment;
        else if (queryCoor - m_queryPerfectMatchStart ==
            subjCoor - m_subjectPerfectMatchStart)
            return m_matchMatrix[(int)CharEnum(queryNt),(int)CharEnum(subjectNt)];
        else
            return m_perfectMatchPunishment;
    }
    else

```

```

{
    if (m_queryCenterBulge[queryCoor])
        return m_qcb_match;
    else
        return m_matchMatrix[(int)CharEnum(queryNt),(int)CharEnum(subjectNt)];
}
}

```

```

public int QueryGapOpen(int queryCoor, int subjCoor, int queryLen)

```

```

{
    if (m_queryCenterBulge[queryCoor])
        return m_qcb_queryGapOpen;
    else
        return m_queryGapOpen;
}

```

```

public int QueryGapExt(int queryCoor, int subjCoor, int queryLen)

```

```

{
    if(IsPartOfPerfectMatch(queryCoor))
        return m_perfectMatchPunishment;
    else
    {
        if (m_queryCenterBulge[queryCoor])
            return m_qcb_queryGapExt;
        else
            return m_queryGapExt;
    }
}

```

```

public int SubjectGapOpen(int queryCoor, int subjCoor, int queryLen)

```

```

{
    if (queryCoor == -1)
        return 0;
    else
    {
        if (m_queryCenterBulge[queryCoor])
            return m_qcb_subjectGapOpen;
        else
            return m_subjectGapOpen;
    }
}

```

```

public int SubjectGapExt(int queryCoor, int subjCoor, int queryLen)

```

```

{
    if (queryCoor == -1)
        return 0;
    else if (IsPartOfPerfectMatch(queryCoor))
        return m_perfectMatchPunishment;
    else
    {
        if (m_queryCenterBulge[queryCoor])
            return m_qcb_subjectGapExt;
        else

```

```

    return m_subjectGapExt;
}
}
public int MisMatchOpen(int queryCoor, int subjCoor, int queryLen)
{
    if (m_queryCenterBulge[queryCoor])
        return m_qcb_misMatchOpen;
    else
        return m_misMatchOpen;
}

public CharE CharEnum(char c)
{
    if(c == 'A' || c == 'a')
        return CharE.A;
    else if (c == 'G' || c == 'g')
        return CharE.G;
    else if (c == 'T' || c == 't')
        return CharE.T;
    else if (c == 'C' || c == 'c')
        return CharE.C;
    else if (c == 'N' || c == 'n')
    {
        GPLogger.Instance.Info("Alignment Param was Asked align N char. N chars can be in the subject output!!!");
        return CharE.N;
    }
    else if (c == 'Z' || c == 'z')
    {
        ArgumentException e = new ArgumentException("trying to align char Z: the input query or subject are not clean and
include characters that are not; A/T/G/C/N");
        GPLogger.Instance.Error(e);
        throw e;
    }
    else
        throw new ArgumentException("illegal char to align:" + c);
}

public bool IsMatch(char queryChar, char subjectChar)
{
    if ( (queryChar == 'A' && subjectChar == 'T') ||
        (queryChar == 'T' && subjectChar == 'A') ||
        (queryChar == 'C' && subjectChar == 'G') ||
        (queryChar == 'G' && subjectChar == 'C') ||
        (queryChar == 'G' && subjectChar == 'T') ||
        (queryChar == 'T' && subjectChar == 'G') )
        return true;
    else
        return false;
}

public int QueryPerfectMatchStart
{

```

```

    get
    {
        return m_queryPerfectMatchStart;
    }
}
public int SubjectPerfectMatchStart
{
    get
    {
        return m_subjectPerfectMatchStart;
    }
}
public int PerfectMatchLen
{
    get
    {
        return m_perfectMatchLen;
    }
}
}
using System;
using System.Collections;
using GPLogging;
namespace IndexService
{
    /// <summary>
    ///
    /// </summary>
    public class SubjectFreeEndsAlignment
    {
        AlignmentEntry[,] m_alignmentMatrix;
        AlignmentParams m_params;
        int m_MatrixQueryLen;
        int m_MatrixSubjectLen;
        int m_bestScore;
        bool m_bestScoreInit = false;
        char[] m_queryChar;
        char[] m_subjectChar;
        public SubjectFreeEndsAlignment(char[] query,char[] subject): this(query,subject, 0, 0, 0)
        {
            // alignment with no perfect match
        }
        public SubjectFreeEndsAlignment(char[] query,char[] subject,
            int queryStartPerfectMatch,
            int subjectStartPerfectMatch,
            int perfectMatchLen)
        {
            try
            {

```

```

m_queryChar = query;
m_subjectChar = subject;
m_params =
    new AlignmentParams(query.Length,
        queryStartPerfectMatch,
        subjectStartPerfectMatch,
        perfectMatchLen);
m_MatrixQueryLen = query.Length + 1;
m_MatrixSubjectLen = subject.Length + 1;
m_alignmentMatrix = new AlignmentEntry[query.Length + 1, subject.Length + 1];
for (int queryIndex = 0; queryIndex <= query.Length; ++queryIndex)
{
    for (int subjectIndex = 0; subjectIndex <= subject.Length; ++subjectIndex)
    {
        if (queryIndex == 0 || subjectIndex == 0)
        {
            if (queryIndex != 0 && subjectIndex == 0)
            {
                m_alignmentMatrix[queryIndex,subjectIndex] =
                    new AlignmentEntry(subject,query,subjectIndex - 1,queryIndex - 1,
                        new AlignmentEntry[] {null,
                            null,
                            m_alignmentMatrix[queryIndex - 1,subjectIndex]});
            }
            else if (queryIndex == 0 && subjectIndex != 0)
            {
                m_alignmentMatrix[queryIndex,subjectIndex] =
                    new AlignmentEntry(subject,query,subjectIndex - 1,queryIndex - 1,
                        new AlignmentEntry[] {m_alignmentMatrix[queryIndex,subjectIndex - 1],
                            null,
                            null});
            }
            else
            {
                m_alignmentMatrix[queryIndex,subjectIndex] =
                    new AlignmentEntry(subject,query,subjectIndex - 1,queryIndex - 1,
                        new AlignmentEntry[] {null,
                            null,
                            null});
            }
            /*
            m_alignmentMatrix[queryIndex,subjectIndex] =
                new AlignmentEntry(subject,query,subjectIndex - 1,queryIndex - 1);*/
        }
        else
        {
            m_alignmentMatrix[queryIndex,subjectIndex] =
                new AlignmentEntry(subject,query,subjectIndex - 1,queryIndex - 1,
                    new AlignmentEntry[] {m_alignmentMatrix[queryIndex,subjectIndex - 1],
                        m_alignmentMatrix[queryIndex - 1,subjectIndex - 1],
                        m_alignmentMatrix[queryIndex - 1,subjectIndex]});
        }
    }
}
for (int subjectIndex = 0; subjectIndex <= subject.Length; ++subjectIndex)
{

```

```

    m_alignmentMatrix[0,subjectIndex].CalAlignment(m_params);
}
for (int queryIndex = 0; queryIndex <= query.Length; ++queryIndex)
{
    m_alignmentMatrix[queryIndex,0].CalAlignment(m_params);
}

for (int queryIndex = 1; queryIndex <= query.Length; ++queryIndex)
{
    for (int subjectIndex = 1; subjectIndex <= subject.Length; ++subjectIndex)
    {
        m_alignmentMatrix[queryIndex,subjectIndex].CalAlignment(m_params);
    }
}
}
catch(Exception e)
{
    GPLLogger.Instance.Error(e);
    throw e;
}
}
public int BestScore
{
    get
    {
        if (m_bestScoreInit)
            return m_bestScore;

        int maxScore = m_alignmentMatrix[m_MatrixQueryLen - 1,0].Score;
        for (int subjectIndex = 1; subjectIndex < m_MatrixSubjectLen; ++subjectIndex)
        {
            maxScore = Math.Max(maxScore,m_alignmentMatrix[m_MatrixQueryLen - 1,subjectIndex].Score);
        }
        m_bestScore = maxScore;
        m_bestScoreInit = true;
        return maxScore;
    }
}
public int[,] GetBestAlignmentSubjectCoordinates()
{
    int bestScore = BestScore;
    int countArray = 0;
    for (int subjectIndex = 1; subjectIndex < m_MatrixSubjectLen; ++subjectIndex)
    {
        if (m_alignmentMatrix[m_MatrixQueryLen - 1,subjectIndex].Score == bestScore)
        {
            countArray += m_alignmentMatrix[m_MatrixQueryLen - 1,subjectIndex].SubjectStartNum;
        }
    }
    int[, ] bestScores = new int[countArray,2];

```

```

int resIndex = 0;
for (int subjectIndex = 1; subjectIndex < m_MatrixSubjectLen; ++subjectIndex)
{
    if (m_alignmentMatrix[m_MatrixQueryLen - 1,subjectIndex].Score == bestScore)
    {
        BitArray subjectStartArr;
        subjectStartArr = m_alignmentMatrix[m_MatrixQueryLen - 1,subjectIndex].SubjectStartArray;
        for (int i = 0; i < subjectStartArr.Length; ++i)
        {
            if (subjectStartArr[i])
            {
                bestScores[resIndex,0] = i;
                bestScores[resIndex,1] = subjectIndex - 1;
                ++resIndex;
            }
        }
    }
}
return bestScores;
}

public string[] GetAllBestTrackBacks()
{
    int bestScore = BestScore;
    int countArray = 0;
    for (int subjectIndex = 1; subjectIndex < m_MatrixSubjectLen; ++subjectIndex)
    {
        if (m_alignmentMatrix[m_MatrixQueryLen - 1,subjectIndex].Score == bestScore)
        {
            countArray += m_alignmentMatrix[m_MatrixQueryLen - 1,subjectIndex].SubjectStartNum;
        }
    }
    string[] bestTrackBacks = new string[countArray];
    int resIndex = 0;
    int temp;// subject real start coordinates
    for (int subjectIndex = 1; subjectIndex < m_MatrixSubjectLen; ++subjectIndex)
    {
        if (m_alignmentMatrix[m_MatrixQueryLen - 1,subjectIndex].Score == bestScore)
        {
            BitArray subjectStartArr;
            subjectStartArr = m_alignmentMatrix[m_MatrixQueryLen - 1,subjectIndex].SubjectStartArray;
            for (int i = 0; i < subjectStartArr.Length; ++i)
            {
                if (subjectStartArr[i])
                {
                    bestTrackBacks[resIndex] = TrackBack(i, subjectIndex - 1,out temp);
                    ++resIndex;
                }
            }
        }
    }
}

```

```

    return bestTrackBacks;
}
public string GetOneOfTheBestTrackBacks()
{
    int temp1, temp2;
    return GetOneOfTheBestTrackBacks(out temp1, out temp2);
}
/// <summary>
/// TODO double code - delete unused method
/// return with subject left free end draw
/// </summary>
/// <param name="subjStartCoor"> out for the alignment real subj start coor</param>
/// <param name="subjEndCoor">out for the alignment real subj start coor</param>
/// <returns>return un reversed char[,4] array</returns>
public char[,] GetOneOfTheBestTrackBacksCharArr(out int subjStartCoor,
        out int subjEndCoor)
{
    int bestScore = BestScore;
    for (int subjectIndex = 1; subjectIndex < m_MatrixSubjectLen; ++subjectIndex)
    {
        if (m_alignmentMatrix[m_MatrixQueryLen - 1,subjectIndex].Score == bestScore)
        {
            BitArray subjectStartArr;
            subjectStartArr = m_alignmentMatrix[m_MatrixQueryLen - 1,subjectIndex].SubjectStartArray;
            for (int i = 0; i < subjectStartArr.Length; ++i)
            {
                if (subjectStartArr[i])
                {
                    subjEndCoor = subjectIndex - 1;
                    int charArrEndIndex;
                    char[,] reversedCharArr =
                        TrackBack(i,subjEndCoor,
                            out subjStartCoor, out charArrEndIndex, true);
                    WarnAboutNChar(subjStartCoor, subjEndCoor);
                    return ReturnReversedCharArr(reversedCharArr,charArrEndIndex);
                }
            }
        }
    }
    throw new ArgumentException("the track back didn't found any track with maximal score");
}
private void WarnAboutNChar(int subjStartCoor, int subjEndCoor)
{
    if (subjStartCoor < 0 || subjEndCoor >= m_subjectChar.Length ||
        subjStartCoor > subjEndCoor)
        throw new ArgumentException("Alignment best track - start end coordinate not right:" + subjStartCoor + " / " +
            subjEndCoor);
    for (int i = 0; i < m_queryChar.Length; ++i)
    {
        if (m_params.CharEnum(m_queryChar[i]) == AlignmentParams.CharE.N)
    }

```

```

{
    GPLLogger.Instance.Warn("Alignment: query might contain N chars.");
}
}
for (int i = subjStartCoor; i <= subjEndCoor ; ++i)
{
    if (m_params.CharEnum(m_subjectChar[i]) == AlignmentParams.CharE.N)
    {
        GPLLogger.Instance.Warn("Alignment: subject might contain N chars.");
    }
}
}
public string GetOneOfTheBestTrackBacks(out int subjStartCoor,
out int subjEndCoor)
{
    int bestScore = BestScore;
    for (int subjectIndex = 1; subjectIndex < m_MatrixSubjectLen; ++subjectIndex)
    {
        if (m_alignmentMatrix[m_MatrixQueryLen - 1,subjectIndex].Score == bestScore)
        {
            BitArray subjectStartArr;
            subjectStartArr = m_alignmentMatrix[m_MatrixQueryLen - 1,subjectIndex].SubjectStartArray;
            for (int i = 0; i < subjectStartArr.Length; ++i)
            {
                if (subjectStartArr[i])
                {
                    {
                        subjEndCoor = subjectIndex - 1;
                        return TrackBack(i, subjectIndex - 1, out subjStartCoor);
                    }
                }
            }
        }
    }
    throw new ArgumentException("the track back didn't found any track with minimal score");
}
private char[,] ReturnReversedCharArr(char[,] reversedCharArr,int charArrEndIndex)
{
    char[,] charArr = new char[charArrEndIndex + 1,4];
    for (int i = charArrEndIndex; i >= 0; --i)
    {
        charArr[charArrEndIndex - i, 0] = reversedCharArr[i,0];
        charArr[charArrEndIndex - i, 1] = reversedCharArr[i,1];
        charArr[charArrEndIndex - i, 2] = reversedCharArr[i,2];
        charArr[charArrEndIndex - i, 3] = reversedCharArr[i,3];
    }
    return charArr;
}
private string TrackBack(int subjStartCoor,int subjEndCoor, out int sujRealStartCoor)
{
    int charArrEndIndex;
    char[,] alignPaintArr = TrackBack(subjStartCoor,subjEndCoor, out sujRealStartCoor, out charArrEndIndex);
}

```

```

return CreateTrackBackString(alignPaintArr,charArrEndIndex);
}
private char[,] TrackBack(int subjStartCoor,int subjEndCoor,
    out int sujRealStartCoor, out int charArrEndIndex)
{
    return TrackBack(subjStartCoor,subjEndCoor,
        out sujRealStartCoor, out charArrEndIndex, false);
}
// the Array is reversed
private char[,] TrackBack(int subjStartCoor,int subjEndCoor,
    out int sujRealStartCoor, out int charArrEndIndex, bool isSubjLeftFreeEnd)
{
    char[,] alignPaintArr = new char[subjEndCoor + 1 + m_queryChar.Length,4];
    AlignmentEntry curEntry = m_alignmentMatrix[m_MatrixQueryLen - 1,subjEndCoor + 1];
    int resIndex = 0;
    char queryNt;
    char subjectNt;
    sujRealStartCoor = 0; // default value just for not getting a warning
    while (curEntry.QueryCoor >= 0 || (isSubjLeftFreeEnd && curEntry.SubjectCoor >= 0))
    {
        // for subject left free ends
        if (curEntry.QueryCoor < 0)
        {
            subjectNt = m_subjectChar[curEntry.SubjectCoor];
            if (m_params.PerfectMatchLen > 0)
            {
                if (curEntry.SubjectCoor >= m_params.SubjectPerfectMatchStart &&
                    curEntry.SubjectCoor < m_params.SubjectPerfectMatchStart + m_params.PerfectMatchLen)
                    subjectNt = char.ToLower(subjectNt);
            }
            PaintQueryGap(alignPaintArr, resIndex,
                subjectNt);
            curEntry = curEntry.LeftEntry;
        } // for query that start with a query gap
        else if (curEntry.SubjectCoor < 0)
        {
            queryNt = m_queryChar[curEntry.QueryCoor];
            if (m_params.PerfectMatchLen > 0)
            {
                if (curEntry.QueryCoor >= m_params.QueryPerfectMatchStart &&
                    curEntry.QueryCoor < m_params.QueryPerfectMatchStart + m_params.PerfectMatchLen)
                    queryNt = char.ToLower(queryNt);
            }
            PaintSubjectGap(alignPaintArr, resIndex,
                queryNt);
            curEntry = curEntry.UpEntry;
        }
        else
        {
            queryNt = m_queryChar[curEntry.QueryCoor];

```

```

subjectNt = m_subjectChar[curEntry.SubjectCoor];
if (m_params.PerfectMatchLen > 0)
{
    if (curEntry.QueryCoor >= m_params.QueryPerfectMatchStart &&
        curEntry.QueryCoor < m_params.QueryPerfectMatchStart + m_params.PerfectMatchLen)
        queryNt = char.ToLower(queryNt);
    if (curEntry.SubjectCoor >= m_params.SubjectPerfectMatchStart &&
        curEntry.SubjectCoor < m_params.SubjectPerfectMatchStart + m_params.PerfectMatchLen)
        subjectNt = char.ToLower(subjectNt);
}
// for the real coordinates
if (curEntry.QueryCoor == 0)
    sujRealStartCoor = curEntry.SubjectCoor;
// match
if (curEntry.DiagonalEntry != null && curEntry.IsMatch)
{
    PaintMatch(alignedPaintArr, resIndex,
        queryNt,
        subjectNt);
    curEntry = curEntry.DiagonalEntry;
}
// mismatch
else if (curEntry.DiagonalEntry != null && !curEntry.IsMatch)
{
    PaintMismatch(alignedPaintArr, resIndex,
        queryNt,
        subjectNt);
    curEntry = curEntry.DiagonalEntry;
}
//query gap
else if (curEntry.UpEntry != null)
{
    PaintSubjectGap(alignedPaintArr, resIndex,
        queryNt);
    curEntry = curEntry.UpEntry;
}
// subject gap
else if (curEntry.LeftEntry != null)
{
    PaintQueryGap(alignedPaintArr, resIndex,
        subjectNt);
    curEntry = curEntry.LeftEntry;
}
else
    throw new ArgumentException("Wrong matrix - all entries are null");
}
++resIndex;
}
charArrEndIndex = resIndex - 1;
return alignedPaintArr;

```

```

//return CreateTrackBackString(alignPaintArr,resIndex - 1);
}
public static void PaintMatch(char[,] alignPaintArr, int resIndex,
char queryChar, char subjectChar)
{
alignPaintArr[resIndex,0] = ' ';
alignPaintArr[resIndex,1] = subjectChar;
alignPaintArr[resIndex,2] = queryChar;
alignPaintArr[resIndex,3] = ' ';
}
public static void PaintMisMatch(char[,] alignPaintArr, int resIndex,
char queryChar, char subjectChar)
{
alignPaintArr[resIndex,0] = subjectChar;
alignPaintArr[resIndex,1] = ' ';
alignPaintArr[resIndex,2] = ' ';
alignPaintArr[resIndex,3] = queryChar;
}
public static void PaintSubjectGap(char[,] alignPaintArr, int resIndex,
char queryChar)
{
alignPaintArr[resIndex,0] = '-';
alignPaintArr[resIndex,1] = ' ';
alignPaintArr[resIndex,2] = ' ';
alignPaintArr[resIndex,3] = queryChar;
}
public static void PaintQueryGap(char[,] alignPaintArr, int resIndex,
char subjectChar)
{
alignPaintArr[resIndex,0] = subjectChar;
alignPaintArr[resIndex,1] = ' ';
alignPaintArr[resIndex,2] = ' ';
alignPaintArr[resIndex,3] = '-';
}
private string CreateTrackBackString(char[,] alignPaintArr,
int maxIndex)
{
char[] finalStrChar = new char[4*(maxIndex+1) + 4];
int finalStrIndex = 0;
int index = maxIndex;
for (int i = 0; i < 4; ++i)
{
for (; index >= 0;--index)
{
finalStrChar[finalStrIndex] = alignPaintArr[index,i];
++finalStrIndex;
}
if (i < 3)
{
finalStrChar[finalStrIndex] = '\n';

```

```

        ++finalStrIndex;
    }
    else
    {
        finalStrChar[finalStrIndex] = '\0';
        ++finalStrIndex;
    }
    index = maxIndex;
}
return new string(finalStrChar,0,finalStrIndex - 1);
}
}
}
using System;
namespace IndexService
{
    /// Summary description for WordEditMapper.
    public class WordEditMapper
    {
        private int m_winSize;
        private MapperItem[][] m_mapData;
        public WordEditMapper(int winSize)
        {
            // Initialize the array
            m_winSize = winSize;
            InitData(winSize);
        }
        /// InitData
        /// <param name="stringSize"></param>
        private void InitData(int winSize)
        {
            // Allocate array
            int stringsCount = (int)Math.Pow(4.0, (double)winSize);
            int editsNum = (winSize * 3 * 4) +
                winSize * 4 +
                (winSize - 2) * 4 * 4;
            m_mapData = new MapperItem[stringsCount][];
            for (int count = 0; count < stringsCount; count++)
                m_mapData[count] = new MapperItem[editsNum];
            int currIndex = 0;
            int newStringKey = 0;
            string currString = "";
            string addedLetter1 = "";
            string addedLetter2 = "";
            char currLetter = ' ';
            string newLetter = "";
            string stringStart = "";
            string stringEnd = "";
            bool wordExist = false;
            MapperItem[] partialArray;

```

```

for (int stringIndex = 0; stringIndex < stringsCount; stringIndex++)
{
    currIndex = 0;
    currString = IndexData.IntToWord(stringIndex, winSize);
    // Adding letter to string end
    for (int letterType = 0; letterType < 4; letterType++)
    {
        switch (letterType)
        {
            case 0:
                newStringKey =
                    IndexData.WordToInt(currString + "A", (winSize + 1));
                break;
            case 1:
                newStringKey =
                    IndexData.WordToInt(currString + "C", (winSize + 1));
                break;
            case 2:
                newStringKey =
                    IndexData.WordToInt(currString + "G", (winSize + 1));
                break;
            case 3:
                newStringKey =
                    IndexData.WordToInt(currString + "T", (winSize + 1));
                break;
        }
        newStringKey = IndexData.IntToRevCompInt(newStringKey, (winSize + 1));
        m_mapData[stringIndex][currIndex] = new MapperItem();
        m_mapData[stringIndex][currIndex].WordKey = newStringKey;
        m_mapData[stringIndex][currIndex].ActionPerformed =
            MapperItem.Action.NONE;
        currIndex++;
    }
    // Replace letter + Add to end
    for (int letterIndex = 0; letterIndex < winSize; letterIndex++)
    {
        currLetter = currString[letterIndex];
        if (letterIndex == 0)
            stringStart = "";
        else
            stringStart = currString.Substring(0, letterIndex);
        if (letterIndex == (winSize - 1))
            stringEnd = "";
        else
            stringEnd = currString.Substring(letterIndex + 1,
                winSize - letterIndex - 1);
        for (int repLetter = 0; repLetter < 3; repLetter++)
        {
            switch (repLetter)
            {

```

```
case 0:
switch (currLetter)
{
case 'A':
    newLetter = "C";
    break;
case 'C':
    newLetter = "A";
    break;
case 'G':
    newLetter = "A";
    break;
case 'T':
    newLetter = "A";
    break;
}
break;
case 1:
switch (currLetter)
{
case 'A':
    newLetter = "G";
    break;
case 'C':
    newLetter = "G";
    break;
case 'G':
    newLetter = "C";
    break;
case 'T':
    newLetter = "C";
    break;
}
break;
case 2:
switch (currLetter)
{
case 'A':
    newLetter = "T";
    break;
case 'C':
    newLetter = "T";
    break;
case 'G':
    newLetter = "T";
    break;
case 'T':
    newLetter = "G";
    break;
}
```

```

        break;
    }
    for (int letterType = 0; letterType < 4; letterType++)
    {
        switch (letterType)
        {
            case 0:
                newStringKey =
                    IndexData.WordToInt(stringStart +
                        newLetter +
                        stringEnd +
                        "A", (winSize + 1));
                break;
            case 1:
                newStringKey =
                    IndexData.WordToInt(stringStart +
                        newLetter +
                        stringEnd +
                        "C", (winSize + 1));
                break;
            case 2:
                newStringKey =
                    IndexData.WordToInt(stringStart +
                        newLetter +
                        stringEnd +
                        "G", (winSize + 1));
                break;
            case 3:
                newStringKey =
                    IndexData.WordToInt(stringStart +
                        newLetter +
                        stringEnd +
                        "T", (winSize + 1));
                break;
        }
        newStringKey = IndexData.IntToRevCompInt(newStringKey,
            (winSize + 1));
        m_mapData[stringIndex][currIndex] = new MapperItem();
        m_mapData[stringIndex][currIndex].WordKey =
            newStringKey;
        m_mapData[stringIndex][currIndex].ActionPerformed =
            MapperItem.Action.REPLACE;
        m_mapData[stringIndex][currIndex].ActionPosition =
            letterIndex;
        currIndex++;
    }
}
// Insert letter
for (int letterIndex = 1; letterIndex < winSize; letterIndex++)

```

```

{
//insert only inside the string
stringStart = currString.Substring(0, letterIndex);
stringEnd = currString.Substring(letterIndex,
    winSize - letterIndex);
for (int letterType = 0; letterType < 4; letterType++)
{
switch (letterType)
{
case 0:
newStringKey =
IndexData.WordToInt(stringStart +
    "A" +
    stringEnd,
    (winSize + 1));
break;
case 1:
newStringKey =
IndexData.WordToInt(stringStart +
    "C" +
    stringEnd,
    (winSize + 1));
break;
case 2:
newStringKey =
IndexData.WordToInt(stringStart +
    "G" +
    stringEnd,
    (winSize + 1));
break;
case 3:
newStringKey =
IndexData.WordToInt(stringStart +
    "T" +
    stringEnd,
    (winSize + 1));
break;
}
wordExist = false;
newStringKey = IndexData.IntToRevComplnt(newStringKey,
    (winSize + 1));
for (int words = 0;
    (words < currIndex) && (wordExist == false);
    words++)
{
if (m_mapData[stringIndex][words].WordKey ==
    newStringKey)
{
wordExist = true;
}
}
}

```

```

}
if (wordExist == false)
{
    m_mapData[stringIndex][currIndex] = new MapperItem();
    m_mapData[stringIndex][currIndex].WordKey =
        newStringKey;
    m_mapData[stringIndex][currIndex].ActionPerformed =
        MapperItem.Action.INSERT;
    m_mapData[stringIndex][currIndex].ActionPosition =
        letterIndex;
    currIndex++;
}
}
}
// Delete letter and add to end
for (int letterIndex = 1; letterIndex < winSize - 1; letterIndex++)
{
    //delete only inside the string
    stringStart = currString.Substring(0, letterIndex);
    stringEnd = currString.Substring(letterIndex + 1,
        winSize - letterIndex - 1);
    for (int letterType2 = 0; letterType2 < 4; letterType2++)
    {
        switch (letterType2)
        {
            case 0:
                addedLetter2 = "A";
                break;
            case 1:
                addedLetter2 = "C";
                break;
            case 2:
                addedLetter2 = "G";
                break;
            case 3:
                addedLetter2 = "T";
                break;
        }
    }
    for (int letterType1 = 0; letterType1 < 4; letterType1++)
    {
        switch (letterType1)
        {
            case 0:
                addedLetter1 = "A";
                break;
            case 1:
                addedLetter1 = "C";
                break;
            case 2:
                addedLetter1 = "G";

```

```

        break;
    case 3:
        addedLetter1 = "T";
        break;
    }
    newStringKey =
        IndexData.WordToInt(stringStart + stringEnd +
            addedLetter1 + addedLetter2,
            (winSize + 1));
    newStringKey = IndexData.IntToRevCompInt(newStringKey,
        (winSize + 1));
    wordExist = false;
    for (int words = 0;
        (words < currIndex) && (wordExist == false);
        words++)
    {
        if (m_mapData[stringIndex][words].WordKey ==
            newStringKey)
        {
            wordExist = true;
        }
    }
    if (wordExist == false)
    {
        m_mapData[stringIndex][currIndex] = new MapperItem();
        m_mapData[stringIndex][currIndex].WordKey =
            newStringKey;
        m_mapData[stringIndex][currIndex].ActionPerformed =
            MapperItem.Action.DELETE;
        m_mapData[stringIndex][currIndex].ActionPosition =
            letterIndex;
        currIndex++;
    }
}
}
}
partialArray = new MapperItem[currIndex];
Array.Copy(m_mapData[stringIndex], partialArray, currIndex);
m_mapData[stringIndex] = partialArray;
} //Main for
}
public MapperItem[] GetDerivedWords(int key)
{
    return m_mapData[key];
}
public int WinSize
{
    get {return m_winSize;}
}
}

```

```

}
using System;
using BasicTypes;
namespace IndexService
{
    /// <summary>
    /// Summary description for FalseDiscoveryRateCal.
    /// </summary>
    public class FalseDiscoveryRateCal
    {
        int m_totalTestNum;
        FloatSet m_sortPValArr;
        public FalseDiscoveryRateCal(FloatSet pValArr, int totalTestNum)
        {
            m_totalTestNum = totalTestNum;
            pValArr.Sort();
            m_sortPValArr = pValArr;
        }

        public float CalFalseDiscoveryRate(float pVal)
        {
            int pValPos = LionInDesertFinder(m_sortPValArr,pVal)+1;
            return m_totalTestNum*pVal/pValPos;
        }

        int LionInDesertFinder(FloatSet arr, float val)
        {
            int lowerBound = 0;
            int HigherBound = arr.Count - 1;
            if (val < arr[lowerBound] || val > arr[HigherBound])
                return -1;
            while (HigherBound-lowerBound>1)
            {
                if (val >= arr[lowerBound + (HigherBound-lowerBound)/2])
                    lowerBound = lowerBound + (HigherBound-lowerBound)/2;
                else
                    HigherBound = lowerBound + (HigherBound-lowerBound)/2;
            }
            return lowerBound;
        }
    }
}
using System;
using System.Collections;
using BasicTypes;
namespace IndexService
{
    /// <summary>
    /// Summary description for OrthologFamily.
    /// </summary>

```

```

public class OrthologFamily : ArrayList
{
    private int m_familyId;
    private int m_utrSide;
    public OrthologFamily(int familyId,int utrSide):base()
    {
        m_familyId=familyId;
        m_utrSide=utrSide;
    }
    public int FamilyId
    {
        get {return m_familyId;}
        set {m_familyId=value;}
    }
    public int UtrSide
    {
        get {return m_utrSide;}
        set {m_utrSide=value;}
    }
    public int Add(UtrKey utrKey) { return base.Add(utrKey); }

    public override int Add(object o) { throw new ArgumentException("Only UtrKey objects can be added to
OrthologFamily."); }
    public new UtrKey this[int index]
    {
        get
        {
            return (UtrKey) base[index];
        }
        set
        {
            base[index] = value;
        }
    }
    public string[] GetOrtologsOrganisms(string srcOrganism)
    {
        ArrayList organisms=new ArrayList();
        for(int i=0;i<Count;i++)
        {
            if(this[i].Organism != srcOrganism)
                organisms.Add(this[i].Organism);
        }
        removeOrganismDup(organisms);
        return (string[])organisms.ToArray(typeof(string));
    }
    private void removeOrganismDup(ArrayList organisms)
    {
        organisms.Sort();
        string curOrg="NONE";
    }

```

```

int index=0;
while(index<organisms.Count)
{
    if((string)organisms[index]==curOrg)
        organisms.RemoveAt(index);
    else
    {
        curOrg=(string)organisms[index];
        index++;
    }
}

public UtrKey[] GetOrtologs(string srcOrganism)
{
    ArrayList utrKeys=new ArrayList();
    for(int i=0;i<Count;i++)
    {
        if(this[i].Organism != srcOrganism)
            utrKeys.Add(this[i]);
    }
    return (UtrKey[])utrKeys.ToArray(typeof(UtrKey));
}

public UtrKey[] GetUtrsKeyByOrganism(string srcOrganism)
{
    ArrayList utrKeys=new ArrayList();
    for(int i=0;i<Count;i++)
    {
        if(this[i].Organism == srcOrganism)
            utrKeys.Add(this[i]);
    }
    return (UtrKey[])utrKeys.ToArray(typeof(UtrKey));
}

}

using System;
using System.Collections;
using System.Data;
using System.Data.OleDb;
using DataBaseGate;
using BasicTypes;
namespace IndexService
{
    /// <summary>
    /// Summary description for OrthologyMap.
    /// </summary>
    public class OrthologyMap
    {
        private string m_orthologMapperLogicName;
        private DBLogicTableMapper m_logicTableMapper;

```

```

private Hashtable m_utrKeyHash=new Hashtable();
private bool m_isInitlize=false;
public OrthologyMap(DBLogicTableMapper logicTableMapper,string orthologMapperLogicName)
{
    m_orthologMapperLogicName=orthologMapperLogicName;
    m_logicTableMapper=logicTableMapper;
}
public void Init()
{
    OleDbConnection con=m_logicTableMapper.GetTblDBCon(m_orthologMapperLogicName);
    string
tableName=m_logicTableMapper.GetTblName(m_orthologMapperLogicName,DBLogicTableMapper.TblSuffixType.N
ONE);
    string selectSQL="select " +
        DBConsts.ORTHOLOG_UTR_ID + "," +
        DBConsts.ORTHOLOG_FAMILY + "," +
        DBConsts.ORTHOLOG_SPECIES + "," +
        DBConsts.ORTHOLOG_UTR_SIDE +
        " from " + tableName +
        " order by " + DBConsts.ORTHOLOG_FAMILY + "," +
        DBConsts.ORTHOLOG_UTR_SIDE + "," +
        DBConsts.ORTHOLOG_SPECIES;
    DataTable orthoDt=DBGate.getDataSet(selectSQL,tableName,con).getDataTable();
    int curUtrSide=-1;
    int curOrthoFamily=-1;
    OrthologFamily curOrthologFamily=null;
    foreach(DataRow dr in orthoDt.Rows)
    {
        if((int)dr[DBConsts.ORTHOLOG_FAMILY]!=curOrthoFamily ||
(int)dr[DBConsts.ORTHOLOG_UTR_SIDE]!=curUtrSide)
        {
            curUtrSide=(int)dr[DBConsts.ORTHOLOG_UTR_SIDE];
            curOrthoFamily=(int)dr[DBConsts.ORTHOLOG_FAMILY];
            curOrthologFamily=new OrthologFamily(curOrthoFamily,curUtrSide);
        }
        UtrKey curUtrKey=new
UtrKey((int)dr[DBConsts.ORTHOLOG_UTR_ID],((string)dr[DBConsts.ORTHOLOG_SPECIES]).ToUpper());
        curOrthologFamily.Add(curUtrKey);
        //add to ht
        m_utrKeyHash.Add(curUtrKey,curOrthologFamily);
    }
    m_isInitlize=true;
}
public OrthologFamily GetOrthologFamily(UtrKey utrKey)
{
    if(!m_isInitlize)
        Init();
    if(!m_utrKeyHash.ContainsKey(utrKey))
        return null;
    return (OrthologFamily)m_utrKeyHash[utrKey];
}

```

```

}
public UtrKey[] GetUtrsKeyByOrganism(UtrKey utrKey)
{
    OrthologFamily of=GetOrthologFamily(utrKey);
    if(null == of)
        return null;
    return of.GetUtrsKeyByOrganism(utrKey.Organism);
}

//retrieve all utrkeys from organism other than utrKey
public UtrKey[] GetOrtologs(UtrKey utrKey)
{
    OrthologFamily of= GetOrthologFamily(utrKey);
    if(null == of)
        return null;
    return of.GetOrtologs(utrKey.Organism);
}
public string[] GetOrthologOrganisms(UtrKey utrKey)
{
    OrthologFamily of= GetOrthologFamily(utrKey);
    if(null == of)
        return null;
    return of.GetOrtologsOrganisms(utrKey.Organism);
}
}
}

using System;
using System.Data;
using System.Data.OleDb;
using System.Xml.Serialization;
using System.Collections;
using System.Text;
using GPLogging;
using DataBaseGate;
using System.Diagnostics;
using BasicTypes;
using System.IO;

namespace IndexService
{
    /// <summary>
    /// Summary description for IndexBulder.
    /// </summary>
    public class IndexData
    {
        private int m_windowSize;
        // the word-index arrays
        private int[] m_allocArray = null;
        private int[][] m_curSeqIndexDB = null;
        private IndexHashtable[] m_indexDB = null;

```

```
public const int MIN_WIN_SIZE = 4;
public const int MAX_WIN_SIZE = 12;
public const int m_MAX_LETTERS_IN_INT = 15;
//public const int SQL_CSHARP_INDEX_DIFF = 1;
```

```
public IndexData(SeqInfo[] seqsInfo, int windowSize)
{
    if (seqsInfo == null)
        throw new ArgumentException("IndexData constructor got empty seqsInfo");

    if (windowSize < MIN_WIN_SIZE || windowSize > MAX_WIN_SIZE)
        throw new ArgumentException("IndexData constructor got illegal window size:" + windowSize);

    m_windowSize = windowSize;

    BuildIndex(seqsInfo, windowSize);
}
```

```
public void Terminate()
{
    m_allocArray = null;
    if (m_indexDB != null)
    {
        for(int i = 0; i < m_indexDB.Length; ++i)
        {
            if (m_indexDB[i] != null)
                m_indexDB[i].Clear();

            m_indexDB[i] = null;
        }
    }
    m_indexDB = null;

    if (m_curSeqIndexDB != null)
    {
        for(int i = 0; i < m_curSeqIndexDB.Length; ++i)
        {
            m_curSeqIndexDB[i] = null;
        }
    }
    m_curSeqIndexDB = null;
}
```

```
public void BuildIndex(SeqInfo[] seqsInfo, int windowSize)
{
```

```

// for freeing memory
m_allocArray = null;
m_indexDB = null;

// allocating the arrays

AllocateIndexDB();
ResetIndexDB();

AllocateAllocArray();
ResetAllocArray();

AllocateCurSeqIndexDB();
ResetCurSeqIndexDB();

int j = 0;
for (int i = 0; i < seqsInfo.Length; ++i)
{
    IndexSeq(seqsInfo[i], true);
    AllocateCurSeqIndexDBEntries();
    IndexSeq(seqsInfo[i], false);

    AddCurSeqIndexDBToIndexDB(seqsInfo[i].SeqId);

    ResetAllocArray();
    ResetCurSeqIndexDB();

    if (i == (int)(j * ((float)(seqsInfo.Length - 1) / 10)))
    {
        GPLogger.Instance.Info("Indexed: " + (i + 1) + " from " + seqsInfo.Length + " which are: " + (j*10) + "% of the
sequences");
        ++j;
    }
}

// freeing memory
m_allocArray = null;
m_curSeqIndexDB = null;

////GPLogger.Instance.Info("VM size:" + Process.GetCurrentProcess().VirtualMemorySize);

}

public static int WordToInt(string cur_seq, int windowSize)
{
    // error sequence
    if (NotLeagalSeq(cur_seq))
        return -1;

```

```

if (cur_seq.Length != windowSize)
{
    throw new ArgumentException("word length not like window length: " + cur_seq);
}
if (cur_seq.Length > m_MAX_LETTERS_IN_INT)
{
    throw new ArgumentException("word too long to index: " + cur_seq);
}

```

```

int res=0;
int curInt;

```

```

for(int i=0; i < cur_seq.Length ;i++)
{
    curInt = CharToInt(cur_seq[i]);

    if (curInt == -1)
        throw new ArgumentException("Not legal word");

    res = res | (curInt << (i * 2));

}
return res;
}

```

```

// TODO write without the need to pass through string
public static int IntToRevComplInt(int key, int wordLen)
{

```

```

    if (wordLen > m_MAX_LETTERS_IN_INT)
        throw new ArgumentException("too long word - comp int from int");

```

```

    int revComplInt = 0;

```

```

    int curInt;

```

```

    for (int i = 0; i < wordLen; ++i)
    {
        curInt = IntCharToComplIntChar((key >> (2 * i)) % 4);

        revComplInt = revComplInt | (curInt << (2*(wordLen - 1 - i)));
    }

```

```

    return revComplInt;

```

```

//string wordStr = IntToWorld(key, wordLen);
//string compWord = Sequence.InvRev(wordStr);
//return WordToInt(compWord, wordLen);
}

```

```

public static char IntToChar(int i)
{
    switch(i)
    {
        case(0):
            return 'A';
        case (1):
            return 'G';
        case (2):
            return 'T';
        case (3):
            return 'C';
        default:
            throw new ArgumentException(" illegal int to char");
    }
}

```

```

public static int IntCharToComplIntChar(int i)
{
    switch(i)
    {
        case(0):
            return 2;
        case (1):
            return 3;
        case (2):
            return 0;
        case (3):
            return 1;
        default:
            throw new ArgumentException(" illegal int to char");
    }
}

```

```

public static string IntToWord(int key, int wordLen)
{
    if (wordLen > m_MAX_LETTERS_IN_INT)
        throw new ArgumentException("too long word from int");

    if (wordLen <= 0)
        throw new ArgumentException("word from int: word len not positive: " + wordLen);

    char[] resChar = new char[wordLen];
    int curlnt;

    for (int i = 0; i < wordLen; ++i)
    {

```

```

    curlInt = (key >> (2 * i)) % 4;

    resChar[i] = IntToChar(curlInt);
}

return new string(resChar);

/*
string res = "";
int curlInt;

for (int i = 0; i < wordLen; ++i)
{
    curlInt = (key >> (2 * i)) % 4;

    if (curlInt == 0)
        res = res + "A";
    else if (curlInt == 1)
        res = res + "G";
    else if (curlInt == 2)
        res = res + "T";
    else if (curlInt == 3)
        res = res + "C";
    else
        throw new ArgumentException("error in int to word method logic");
}

return res;*/
}

// -1 error code
public static int CharToInt(char c)
{
    if(c == 'A' || c == 'a')
        return 0;
    else if (c == 'G' || c == 'g')
        return 1;
    else if (c == 'T' || c == 't')
        return 2;
    else if (c == 'C' || c == 'c')
        return 3;
    else
        return -1;
}

public static int CharToComplInt(char c)
{

```

```

if(c == 'A' || c == 'a')
    return CharToInt('T');
else if (c == 'G' || c == 'g')
    return CharToInt('C');
else if (c == 'T' || c == 't')
    return CharToInt('A');
else if (c == 'C' || c == 'c')
    return CharToInt('G');
else
    return -1;
}

```

```

private void IndexSeq(SeqInfo seqInfo, bool onlyCountAllocations)
{
    int word_id = 0;
    int lastOffset = seqInfo.SeqLen - m_windowSize;
    int logCounter = 0;
    try
    {
        if (onlyCountAllocations)
        {

            for (int offset = 0; offset <= lastOffset; ++offset)
            {
                word_id = seqInfo.Seq.ToIndexBuilderInt(offset,m_windowSize);
                //wordToInt(m_subjBitString.ToString(offset,m_windowSize));

                if (word_id != -1)
                {
                    ++(m_allocArray[word_id]);

                    if (lastOffset > 10000 && (offset == (int)(logCounter * ((float)lastOffset / 10))))
                    {
                        GPLLogger.Instance.Info("Indexed: " + (offset + 1) + "nts from " + (lastOffset + 1) + " which are: " + (logCounter*10) +
"% of the seq len");
                        ++logCounter;
                    }
                }
            }
            else
            {
                //TODO remove message
                ////GPLLogger.Instance.Log("Bad word : " + m_subjBitString.Substring(offset,m_windowSize) + " at subjid: " + m_subjId
+ "offset: " + offset );
            }
        }
    }
    else

```

```

{
    // init AllocArray to hold pos
    ResetAllocArray();

    for (int offset = 0; offset <= lastOffset; ++offset)
    {
        word_id = seqInfo.Seq.ToIndexBuilderInt(offset, m_windowSize);
        //wordToInt(m_subjBitString.ToString(offset, m_windowSize));
        if (word_id != -1)
        {
            //m_indexDB[word_id].AddEntry(offset + SQL_CSHARP_INDEX_DIFF);
            //AddIndexDBEntry(word_id, offset + SQL_CSHARP_INDEX_DIFF);
            m_curSeqIndexDB[word_id][m_allocArray[word_id]] = offset; //+ SQL_CSHARP_INDEX_DIFF;
            ++m_allocArray[word_id];
            if (lastOffset > 10000 && (offset == (int)(logCounter * ((float)lastOffset / 10))))
            {
                GPLogger.Instance.Info("Indexed: " + (offset + 1) + "nts from " + (lastOffset + 1) + " which are: " + (logCounter*10) +
"% of the seq len");
                ++logCounter;
            }
        }
        else
        {
            //TODO remove message
            //GPLogger.Instance.W("Bad word ." + m_subjBitString.Substring(offset, m_windowSize) + " at subjid: " + m_subjId +
"offset: " + offset );
        }
    }
}
catch (Exception e)
{
    GPLogger.Instance.Error(" Index seq: " + seqInfo.SeqId + " word id: " + word_id, e);
}
}

public void AddCurSeqIndexDBToIndexDB(int seqId)
{
    SeqPositions seqPos;

    for (int i = 0 ; i < m_curSeqIndexDB.Length; ++i)
    {
        if (m_curSeqIndexDB[i] != null)
        {
            seqPos = new SeqPositions(seqId, m_curSeqIndexDB[i]);

            if (m_indexDB[i] == null)
            {
                m_indexDB[i] = new IndexHashtable();
            }
        }
    }
}

```

```

        m_indexDB[i][seqId] = seqPos;
    }
}

private void AllocateCurSeqIndexDBEntries()
{
    int i=0;
    try
    {
        int max_word_num = GetMaxWordNum();

        m_curSeqIndexDB = new int[max_word_num+1][];

        ResetCurSeqIndexDB();

        int curMax = Max(m_allocArray);

        int curThreshold = 0;
        //int curThreshSub = 0;
        int threshDecrease = 1000;

        ///GPILogger.Instance.Info("Starting allocating by size !!!!!!!");
        ///GPILogger.Instance.Info("before allocation VM size:" + Process.GetCurrentProcess().VirtualMemorySize);

        while (curMax > 0)
        {
            while(2 * threshDecrease > curMax)
            {
                threshDecrease = threshDecrease / 10;
            }
            threshDecrease = Math.Max(threshDecrease,1);

            curThreshold = curMax - threshDecrease;

            ///GPILogger.Instance.Info("After Cal alloc: cur max: " + curMax + "threshDecrease: " + threshDecrease + " thresh: " +
            curThreshold);
            ///GPILogger.Instance.Info("IN PROCESS VM size:" + Process.GetCurrentProcess().VirtualMemorySize);
            curMax = 0;
            for (i = 0; i < m_allocArray.Length ; ++i)
            {
                if (m_allocArray[i] > curThreshold && m_allocArray[i] > 0)
                {
                    m_curSeqIndexDB[i] = new int[m_allocArray[i]]; //IntArray(m_allocArray[i]);

                    for (int j = 0; j < m_curSeqIndexDB[i].Length; ++j)
                    {
                        m_curSeqIndexDB[i][j] = 0;
                    }
                }
            }
        }
    }
}

```

```

    }

    m_allocArray[i] = -1;
}
else
{
    curMax = Math.Max(curMax, m_allocArray[i]);
}
}
}

curMax = Max(m_allocArray);
if (curMax > 0)
    throw new ArgumentException("error in alloc max method: " + curMax);

// release the array
//m_allocArray = null;

}
catch(Exception e)
{
    GPLogger.Instance.Info("Mem ERROR VM size:" + Process.GetCurrentProcess().VirtualMemorySize);
    GPLogger.Instance.Error("Alloc index. index: " + i + " size of array: " + m_allocArray[i], e);
    throw e;
}

}

private int Max(int[] intArr)
{
    if (intArr.Length == 0)
        return int.MinValue;

    int max = intArr[0];

    for (int i = 0; i < intArr.Length; ++i)
    {
        max = Math.Max(max, intArr[i]);
    }
    return max;
}

public int WordToInt(string cur_seq)
{
    // error sequence
    if (NotLegalSeq(cur_seq))

```

```

return -1;

if (cur_seq.Length != m_windowSize)
{
    throw new ArgumentException("word length not like window length: " + cur_seq);
}
if (cur_seq.Length > m_MAX_LETTERS_IN_INT)
{
    throw new ArgumentException("word too long to index: " + cur_seq);
}

int res=0;
int curInt;

for(int i=0; i < cur_seq.Length ;i++)
{
    curInt = CharToInt(cur_seq[i]);

    if (curInt == -1)
        throw new ArgumentException("Not legal word");

    res = res | (curInt << (i * 2));
}
return res;
}

```

```

private int GetMaxWordNum()
{
    return WordToInt(GetMaxWord());
}

```

```

private string GetMaxWord()
{
    return new string('C',m_windowSize);
}

```

```

public static bool NotLegalSeq(string cur_seq)
{
    if (cur_seq.Length==0)
        return true;

    for(int i = 0; i < cur_seq.Length; ++i)
    {
        if ( !( cur_seq[i] == 'A' ||
            cur_seq[i] == 'T' ||

```

```

    cur_seq[i] == 'G' ||
    cur_seq[i] == 'C' ||
    cur_seq[i] == 'a' ||
    cur_seq[i] == 't' ||
    cur_seq[i] == 'g' ||
    cur_seq[i] == 'c'
)
)
return true;
}
return false;
}

```

```

private void AllocateIndexDB()
{
    string max_word=new string('C',m_windowSize);
    int max_word_num = GetMaxWordNum();
    m_indexDB = new IndexHashtable[max_word_num+1];
}

```

```

private void ResetIndexDB()
{
    for (int i = 0;i < m_indexDB.Length;++i)
        m_indexDB[i]= null;
}

```

```

private void AllocateAllocArray()
{
    string max_word=new string('C',m_windowSize);
    int max_word_num = GetMaxWordNum() + 1;
    m_allocArray = new int[max_word_num+1];

}

```

```

private void ResetAllocArray()
{
    for (int i = 0;i < m_allocArray.Length;++i)
        m_allocArray[i]= 0;
}

```

```

private void AllocateCurSeqIndexDB()
{
    string max_word = new string('C',m_windowSize);
    int max_word_num = GetMaxWordNum() + 1;
    m_curSeqIndexDB = new int[max_word_num+1][];
}

```

```

private void ResetCurSeqIndexDB()

```

```

{
    for (int i = 0; i < m_curSeqIndexDB.Length; ++i)
        m_curSeqIndexDB[i] = null;
}

public int GetWinSize()
{
    return m_windowSize;
}

public SeqPositions GetWordPositionsById(string word, int seqId)
{
    if (word.Length != m_windowSize)
        throw new ArgumentException("trying to find positions for word:" + word + " where window size is:" + m_windowSize);

    return GetWordPositionsById(WordToInt(word), seqId);
}

public SeqPositions GetWordPositionsById(int wordKey, int seqId)
{
    try
    {
        if (m_indexDB == null || m_indexDB.Length == 0)
            throw new Exception("Error:Index is empty");

        if (m_indexDB[wordKey] == null)
            return new SeqPositions();
        else if (!m_indexDB[wordKey].ContainsKey(seqId))
            return new SeqPositions();
        else
            return m_indexDB[wordKey][seqId];
    }
    catch (Exception e)
    {
        GPLogger.Instance.Error(e);
        throw e;
    }
}

public IndexHashtable GetWordPositions(string word)
{
    if (word.Length != m_windowSize)
        throw new ArgumentException("GetWordPositions:trying to find positions for word:" + word + " where window size is:"
+ m_windowSize);
}

```

```

return GetWordPositions(WordToInt(word));

}

public IndexHashtable GetWordPositions(int wordKey)
{
    try
    {
        if (m_indexDB == null || m_indexDB.Length == 0)
            throw new Exception("Error:Index is empty");

        if (m_indexDB[wordKey] == null)
            return new IndexHashtable();
        else
            return m_indexDB[wordKey];
    }
    catch(Exception e)
    {
        GPLogger.Instance.Error(e);
        throw e;
    }
}

public IndexHashtable GetWordPositionsAboveThresh(string word, int positionForSeqThresh)
{
    if (word.Length != m_windowSize)
        throw new ArgumentException("GetWordPositions:trying to find positions for word:" + word + " where window size is:"
+ m_windowSize);

    return GetWordPositionsAboveThresh(WordToInt(word), positionForSeqThresh);

}

public IndexHashtable GetWordPositionsAboveThresh(int wordKey, int positionForSeqThresh)
{
    IndexHashtable fullTbl = GetWordPositions(wordKey);

    if (fullTbl == null || fullTbl.Count == 0)
        return fullTbl;

    IndexHashtable aboveThreshTbl = new IndexHashtable();

    for (SeqPositions curSeqPos = fullTbl.First;
        curSeqPos != null;
        curSeqPos = curSeqPos.GetNextAboveLenThresh(positionForSeqThresh))
    {
        aboveThreshTbl.Add(curSeqPos.Id,curSeqPos);
    }
}

```

```

        return aboveThreshTbl;
    }

    public int GetWordAppearCount(int wordKey)
    {
        int appearCount = 0;

        if (m_indexDB[wordKey] != null)
        {
            foreach(SeqPositions seqPos in m_indexDB[wordKey].Values)
            {
                appearCount += seqPos.Length;
            }
        }
        return appearCount;
    }

    public void WriteToFileWordApperenceCount(string filePath)
    {
        FileStream file = new FileStream(filePath, FileMode.Create, FileAccess.ReadWrite);

        StreamWriter sw = new StreamWriter(file);

        for (int i = 0; i < m_indexDB.Length; ++i)
        {
            int appearCount = GetWordAppearCount(i);

            string word = IntToWord(i,m_windowSize);

            sw.WriteLine(word + "\t" + appearCount);
            appearCount = 0;
            word = null;
        }
        sw.Flush();
        sw.Close();

        file.Close();
    }

}

using System;
using System.Text;
using DataBaseGate;
using System.Data;
using System.Data.OleDb;
using System.Collections;
using GPLogging;

```

```

namespace IndexService
{
    /// <summary>
    /// Summary description for IndexInfo.
    /// </summary>
    public class IndexInfo
    {

        private Hashtable m_attributes=new Hashtable();
        private Hashtable m_seqInfoSets=new Hashtable();
        public IndexInfo(OleDbConnection con,string tableName,string idColName,string seqColName,params string[]
attrNames)
        {
            ReadSrcTable(con,tableName,idColName,seqColName,attrNames);
        }
        public ICollection GetAllIds
        {
            get
            {
                return m_seqInfoSets.Keys;
            }
        }
        public int Count
        {
            get
            {
                return m_seqInfoSets.Count;
            }
        }
        private void GetAttrHt(OleDbConnection con,string tableName,string idColName,string seqColName,string
[attrNames)
        {
            //need to read attrNames
            if(attrNames.Length == 0)
            {
                string selectSql="select top 0 * from " + tableName;
                DataTable rowsDt=DBGate.getDataSet(selectSql,tableName,con).getDataTable();
                //we are reading only attributes column and not utr_id or seq columns so -2
                if(rowsDt.Columns.Count-2 > 0)
                {
                    attrNames=new string[rowsDt.Columns.Count-2];
                    int index=0;
                    foreach(DataColumn dc in rowsDt.Columns)
                    {
                        if(dc.ColumnName!=idColName && dc.ColumnName!=seqColName)
                        {
                            if (index >= attrNames.Length)
                                throw new ArgumentException("the seq or id columns are not in the table");
                            attrNames[index]=dc.ColumnName;
                            ++index;
                        }
                    }
                }
            }
        }
    }
}

```

```

    }
}

for(int i=0;i<attrNames.Length;i++)
{
    m_attributes.Add(attrNames[i],i);
}
}

private void ReadSrcTable(OleDbConnection con,string tableName,string idColName,string seqColName,string
[]attrNames)
{
    //create the m_attributes hashtable
    GetAttrHt(con,tableName,idColName,seqColName,attrNames);
    string[] attrs=(string[])new ArrayList(m_attributes.Keys).ToArray(typeof(string));
    //dynamically construct an sql query to retrieve all the attributes from the utr table
    string getAttrSQL="select [" + idColName + " ]";
    foreach(string attr in attrs)
    {
        getAttrSQL+= "[" + attr + " ]";
    }
    getAttrSQL+=" from " + tableName;
    DataTable attrTbl=DBGate.getDataSet(getAttrSQL,tableName,con).getDataTable();
    //construct the m_seqInfoSets hashtable
    int j = 0;
    for (int h = 0; h < attrTbl.Rows.Count; ++h)
    {
        DataRow dr = attrTbl.Rows[h];
        string[] attrArr=new string[attrs.Length];
        for(int i = 0; i < attrs.Length ; ++i)
        {
            attrArr[(int)m_attributes[attrs[i]]]=dr[attrs[i]].ToString();
        }
        StringBuilder seq=DBGate.GetLongStrValById(tableName,seqColName,idColName,dr[idColName].ToString(),con);
        SeqInfo seqInfo=new SeqInfo(seq,(int)dr[idColName],attrArr);
        seq = null;
        m_seqInfoSets.Add((int)dr[idColName],seqInfo);
        if (h == (int)(j * ((float)(attrTbl.Rows.Count - 1) / 10)))
        {
            GPLogger.Instance.Info("Got seq info: " + (h + 1) + " from " + attrTbl.Rows.Count + " which are: " + (j*10) + "% of the
sequences");
            ++j;
        }
    }
}

public SeqInfo this[int SeqId]
{
    get {return (SeqInfo)m_seqInfoSets[SeqId];}
    set {m_seqInfoSets[SeqId]=value;}
}

public string GetAttr(int seqId,string attrName)

```

```

{
    return ((SeqInfo)m_seqInfoSets[seqId])[((int)(m_attributes[attrName]))];
}
public BitString GetSeq(int seqId)
{
    return ((SeqInfo)m_seqInfoSets[seqId]).Seq;
}
public string GetSeq(int seqId,int start,int end,ref int add5,ref int add3)
{
    return ((SeqInfo)m_seqInfoSets[seqId]).GetSeq(start,end,ref add5,ref add3);
}
public SeqInfo[] GetSeqInfoByIdOrder()
{
    ArrayList seqArr=new ArrayList(m_seqInfoSets.Values);
    seqArr.Sort();
    return (SeqInfo[])seqArr.ToArray(typeof(SeqInfo));
}
}
}
using System;
using GPLogging;
using Environment;
using DataBaseGate;
using System.Data;
using System.Data.OleDb;
using FlowManager;
using IndexService;
using IndexManager;
using BasicTypes;
namespace gp_utilities
{
    /// PvalUtrCalc
    public class PvalUtrCalc
    {
        private DBLogicTableMapper m_logMapper;
        private string m_mapTblName = Env.Instance.LogicMapTableName;
        public PvalUtrCalc()
        {
        }
        public void AddUtrBsPvalCalc(String utrLogicTblName)
        {
            string mirsTblName = Env.Instance.NoiseMirsTable;
            string sqlStr;
            OleDbConnection mainCon = DBGate.getConnection(Env.Instance.MainServer, Env.Instance.MainDB);

            m_logMapper = new DBLogicTableMapper(mainCon, m_mapTblName);
            OleDbConnection utrsCon = m_logMapper.GetTblIDBCon(utrLogicTblName);
            // mir seqs
            sqlStr = " select distinct mir_seq from " + mirsTblName;
            DataTable dt = DBGate.getDataSet(sqlStr, mirsTblName, mainCon).getDataTable(mirsTblName);

```

```

string[] mirSeqs = new string[dt.Rows.Count];
for ( int i = 0 ; i < dt.Rows.Count; ++i)
{
    mirSeqs[i] = (string)dt.Rows[i][DBConsts.MIR_SEQ];
}
// free memory
dt = null;
string utrsTblName = m_logMapper.GetTblName(utrLogicTblName,
    DBLogicTableMapper.TblSuffixType.NONE);
sqlStr =
    " SELECT " + DBConsts.UTR_ID + " FROM " +
    m_logMapper.GetTblSelectStr(utrLogicTblName,DBLogicTableMapper.TblSuffixType.NONE,utrsCon) + " A ";
dt = DBGate.getDataSet(sqlStr, utrsTblName, utrsCon).getDataTable(utrsTblName);

MirUtrBsPvalCal mirUtrs;
WordEditMapper wordMapper =
    new WordEditMapper(MirUtrBsPvalCal.UTR_INDEX_WINDOW_SIZE - 1);
SeqsWinIndex seqsWinIndex = IndexMgr.Instance.GetIndex(utrLogicTblName,
    MirUtrBsPvalCal.UTR_INDEX_WINDOW_SIZE);
int j = 0;
for ( int i = 0 ; i < dt.Rows.Count; ++i)
{
    mirUtrs = new MirUtrBsPvalCal(mirSeqs,seqsWinIndex,
        (int)dt.Rows[i][DBConsts.UTR_ID],
        wordMapper);
//eran start - 18 April
    //DBGate.UpdateSingleColumn(utrsTblName,
    // DBConsts.UTR_PVAL_CAL,
    // mirUtrs.ToString(),true,
    // DBConsts.UTR_ID, dt.Rows[i][DBConsts.UTR_ID].ToString(),
    // false, utrsCon);
//eran end
    DBGate.UpdateSingleColumn(utrsTblName,
        DBConsts.UTR_PVAL_CAL,
        mirUtrs.ToString(),
        DBConsts.UTR_ID, dt.Rows[i][DBConsts.UTR_ID].ToString(),
        utrsCon);
    if (i == (int)(j * ((float)(dt.Rows.Count - 1) / 10)))
    {
        GPLogger.Instance.Info("AddUtrBsPvalCalc computed: " +
            (i + 1) + " from " + dt.Rows.Count +
            " which are: " + (j*10) +
            "% of the utrs");
        ++j;
    }
}
string winIndexName = seqsWinIndex.Name;
int winIndexWinSize = seqsWinIndex.WindowSize;
seqsWinIndex = null;

```

```
    IndexMgr.Instance.ReIndex(winIndexName, winIndexWinSize);  
}  
}  
}
```

```

function res = analyse_errors_perc(pos_estimated,score,pos, endbulges)
%analyse_errors_perc(pos_estimated,score,pos, endbulges)
% measure the distribution of erros
N = 100;
perc = [1:-1/N:0]*100;
thresh = prctile(score, perc);
accuracy = zeros(0);
correct_side_dist1 = zeros(0); %correct size, distance = 1;
correct_side_dist2 = zeros(0);
correct_side_dsth = zeros(0);
wrong_side = zeros(0);
fraction = zeros(0);
count = 0;
N = length(pos);
for i = 1:length(endbulges)
    eb = find(endbulges{i});
    correct_side(i) = 0.5*( 1 + sign((pos_estimated(i) - eb(1))*(pos(i) -eb(1))))); %one for correct side estimate
end
for i = 1:length(thresh)
    I = find(score >= thresh(i));
    if ~isempty(I)
        count = count + 1;
        accuracy(count) = sum(pos_estimated(I) == pos(I))/length(I);

        J1 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 1);
        correct_side_dist1(count) = length(J1)/length(I);
        J2 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 2);
        correct_side_dist2(count) = length(J2)/length(I);
        J3 = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) == 3);
        correct_side_dist3(count) = length(J3)/length(I);
        Jh = find(correct_side(I) & abs(pos(I)- pos_estimated(I)) > 3);
        correct_side_dsth(count) = length(Jh)/length(I);

        wrong_side(count) = sum(1-correct_side(I))/length(I);

        fraction(count) = length(I)/N;
    else
        count = count+1;
        accuracy(count) = NaN;
        correct_side_dist1(count) = NaN;
        correct_side_dist2(count) = NaN;
        correct_side_dsth(count) = NaN;
        wrong_side(count) = NaN;
        fraction(count) = NaN;
    end
end

acc1 = accuracy + correct_side_dist1;
acc2 = accuracy + correct_side_dist1 + correct_side_dist2;
acc3 = accuracy + correct_side_dist1 + correct_side_dist2 + correct_side_dist3;

```

```

%clf
hold on

plot(perc, acc3,'y','linewidth',2)
plot(perc, acc2,'g','linewidth',2)
plot(perc, acc1,'r','linewidth',2)
plot(perc, accuracy,'b','linewidth',2)
plot(perc, wrong_side,'k','linewidth',2)
plot(perc, thresh,'c','linewidth',2)
legend('dist \leq 3','dist \leq 2', 'dist \leq 1', 'precise', 'wrong side', 'threshold',2);
xlabel('percentage');
axis([0 100 0 1]);

%keyboard
%prepare result
N = length(accuracy);
res = [accuracy(N), acc1(N), acc2(N), acc3(N), 1-wrong_side(N), acc2(round(0.2*N))];
return
function mfe = anti_inds_to_mfe(anti_inds)
% anti_inds holds for each nuc in the seq what is the index of
% the nuc across from it where the 0 means unpaired (this is returned by read_structure_withanti).
% returns mfe which is the structure in the format of rnafold, i.e. only base pairs:
% mfe is a 2 col matrix, the first being the bases on arm5 which are paired and the second
% their corresponding pairs
if(~iscell(anti_inds))
    mfe = get_mfe(anti_inds);
    return;
end
for i=1:length(anti_inds)
    mfe{i} = get_mfe(anti_inds{i});
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function mfe = get_mfe(ai)
bps=0;
for i=1:length(ai)
    if(ai(i))
        if(i>ai(i))
            return
        end
        bps = bps+1;
        mfe(bps,1) = i;
        mfe(bps,2) = ai(i);
    end
end
end
%ktup, k, alpha
param_sets = [8,4,0.2;
    8,4,0.25;
    8,4,0.3;
    8,5,0.2;

```

```

8,5,0.25;
8,5,0.3;
9,4,0.2;
9,4,0.25;
9,4,0.3];
fid = fopen('batch_results_proto4_A.txt','w');
params1;
maxd = 4;
set_name = model_params.trained_on;
fid = fopen(['zucker_draw_' set_name '.txt'],'r');
[palseq,anti_inds,bulges1,bulges2,endbulges,pal_id,energy,all_pal_ids] = ...
    read_structure_with_id_fid(fid,1000);
fclose(fid);
if(length(pal_id)~=length(all_pal_ids))
    error('in training data do not allow faulty seqs, take out of there');
end
mfes = anti_inds_to_mfe(anti_inds);
fname = ['mirseq_' set_name '.txt'];
[mirseq,mirlen] = read_seq_with_id(fname);
mirpos = locate_dicer(mirseq,palseq);
filename = ['clust_proto_members_' num2str(maxd) '_' set_name '.txt'];
clust_num = load(filename);
if length(clust_num) ~= length(palseq)
    error('clust_num wrong size');
end
for i=1:size(params_sets,1)
    model_params.ktup = param_sets(i,1);
    model_params.k = param_sets(i,2);
    model_params.alpha = param_sets(i,3);
    [pos_est,edist_score,win_score] = mfold_cv_proto_members(mirseq,mirpos,mirlen,palseq,anti_inds,...
        bulges1,bulges2,endbulges,clust_num,model_params);
    score = edist_score; %!!!!!!!!!!!!!!!!!!!!!!!!!!!!
    res = analyse_errors_perc(pos_est,score,mirpos,endbulges);
    fprintf(fid,'%d %d %4.2f %5.3f %5.3f %5.3f %5.3f %5.3f\r\n', model_params.ktup, model_params.k, ...
        model_params.alpha,res(1),res(2),res(3),res(5),res(6));
end
fclose(fid);
function model = bayes_learn_win(seqs,anti_inds,bulges1,bulges2,endbulges,pos,mirlen,model)
%model_params is a struct.
ds_win_len = model.ds_win_len;
% mfes{i} holds the structure in the basepair notation
mfes = anti_inds_to_mfe(anti_inds);
% win_pos(i) is the position of the window corresponding to mir i
if(model.use_mirlen_in_learning_win)
    win_pos = get_win_pos_v1(mfes,anti_inds,pos,mirlen);
else
    win_pos = get_win_pos_v1(mfes,anti_inds,pos,ds_win_len*ones(size(pos)));
end
% for each seq hold the mirposition and all possible positions that are not mirpos
for i=1:length(pos)

```

```

mirwin(i) = win_pos(i);
ai = anti_inds{i};
mfe = mfes{i};
n_bps = size(mfes{i},1);
tt = setdiff([1:n_bps],mirwin(i));
nonmirwins_legal = [];
for j=1:length(tt)
    wp=tt(j);
    pos3_on_arm5 = mfe(wp,1);
    pos5_on_arm3 = mfe(wp,2);
    if((pos3_on_arm5>=model.min_win_len) & (length(ai)-pos5_on_arm3+1>=model.min_win_len))
        nonmirwins_legal = [nonmirwins_legal,wp];
    end
end
nonmirwin{i} = nonmirwins_legal;
end
[mean_loopdist,std_loopdist] = loopdist_bp_model_normal(win_pos,mfes);
model.mean_loopdist_bp = mean_loopdist;
model.std_loopdist_bp = std_loopdist;
[win_num_bps_mir_vals,win_num_bps_mir_ps] = num_bps_model_hist_list(mfes,anti_inds,model,mirwin);
[win_num_bps_nonmir_vals,win_num_bps_nonmir_ps] = num_bps_model_hist_list(mfes,anti_inds,model,nonmirwin);
model.win_num_bps_mir_vals = win_num_bps_mir_vals;
model.win_num_bps_mir_ps = win_num_bps_mir_ps;
model.win_num_bps_nonmir_vals = win_num_bps_nonmir_vals;
model.win_num_bps_nonmir_ps = win_num_bps_nonmir_ps;
[win_sym_mir_vals,win_sym_mir_ps] = win_sym_model_list(mfes,anti_inds,model,mirwin);
[win_sym_nonmir_vals,win_sym_nonmir_ps] = win_sym_model_list(mfes,anti_inds,model,nonmirwin);
model.win_sym_mir_vals = win_sym_mir_vals;
model.win_sym_mir_ps = win_sym_mir_ps;
model.win_sym_nonmir_vals = win_sym_nonmir_vals;
model.win_sym_nonmir_ps = win_sym_nonmir_ps;
[pb_arm5_mir,pb_arm3_mir,pb1_arm5_mir,pb1_arm3_mir,pb2_arm5_mir,pb2_arm3_mir]...
    = win_bulge_pos_model_list(mfes,bulges1,bulges2,model,mirwin);
[pb_arm5_nonmir,pb_arm3_nonmir,pb1_arm5_nonmir,pb1_arm3_nonmir,pb2_arm5_nonmir,pb2_arm3_nonmir]...
    = win_bulge_pos_model_list(mfes,bulges1,bulges2,model,nonmirwin);
model.win_bulge_posit_arm5_mir = pb_arm5_mir;
model.win_bulge_posit_arm3_mir = pb_arm3_mir;
model.win_bulge1_posit_arm5_mir = pb1_arm5_mir;
model.win_bulge1_posit_arm3_mir = pb1_arm3_mir;
model.win_bulge2_posit_arm5_mir = pb2_arm5_mir;
model.win_bulge2_posit_arm3_mir = pb2_arm3_mir;
model.win_bulge_posit_arm5_nonmir = pb_arm5_nonmir;
model.win_bulge_posit_arm3_nonmir = pb_arm3_nonmir;
model.win_bulge1_posit_arm5_nonmir = pb1_arm5_nonmir;
model.win_bulge1_posit_arm3_nonmir = pb1_arm3_nonmir;
model.win_bulge2_posit_arm5_nonmir = pb2_arm5_nonmir;
model.win_bulge2_posit_arm3_nonmir = pb2_arm3_nonmir;
[win_p_bp_arm5_mir,win_p_bp_arm3_mir] = ...
    win_base_pair_model_list(mfes,anti_inds,seqs,model,mirwin);
[win_p_bp_arm5_nonmir,win_p_bp_arm3_nonmir] = ...

```

```

win_base_pair_model_list(mfes,anti_inds,seqs,model,nonmirwin);
model.win_base_pair_arm5_mir = win_p_bp_arm5_mir;
model.win_base_pair_arm3_mir = win_p_bp_arm3_mir;
model.win_base_pair_arm5_nonmir = win_p_bp_arm5_nonmir;
model.win_base_pair_arm3_nonmir = win_p_bp_arm3_nonmir;
return
function [pos,combined_score, edist_score,win_score] = firstkpp_predict_combined(model,
seqs,anti_inds,bulges1,bulges2,endbulges);
% [pos,combined_score,edist_score,win_score] = firstkpp_predict_combined(model,
seqs,anti_inds,bulges1,bulges2,endbulges);
%
% predict best matching miRNA position by edit distance to the first k letters of known mirs
% from the best scoring positions, take the ones with best 2stage score
%
%model contains all learned model, that of bayesian predictor and all known mirs
%seqs is in int format. converted to nucleotide format inside firstkpp_predict1
%
% GD 21.10.03
disp('calculating...');
for i = 1:length(seqs)
    [posi, combined_scorei,edist_scorei, win_scorei] =
firstkpp_predict1(model,seqs{i},anti_inds{i},bulges1{i},bulges2{i},endbulges{i});
    pos(i) = posi;
    combined_score(i) = combined_scorei;
    edist_score(i) = edist_scorei;
    win_score(i) = win_scorei;
end
return
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [pos,combined_score, edist_score, win_score] = firstkpp_predict1(model,seqsi,
anti_indsi,bulges1i,bulges2i,endbulgesi);
%calculate the best matching position of dicer
min_win_len = model.min_win_len;
modelk = model.k;
ktup = model.ktup;
gamma = model.gamma;
lb = find(endbulgesi);
eb_begin = lb(1);
eb_end = lb(end);
%initialize variables with the largest possible distance
mean_k = ktup(ones(length(seqsi),1));
seqsi_nuc = int2nuc(seqsi);
%upper side
for i = 1:1:eb_begin-min_win_len
    p = seqsi_nuc(i:i+ktup-1);
    for j = 1:length(model.seqsd)
        d(j) = editD(p,model.seqsd{j});
    end
    % take also the mean of highest percentile

```

```

[ds,l] = sort(d);
mean_k(i) = mean(ds(1:modelk));
end
%lower side
for i = eb_end+1:1:length(seqsi)-min_win_len+1
    p = seqsi_nuc(i:i+ktup-1);
    for j = 1:length(model.seqsd)
        d(j) = editD(p,model.seqsd{j});
    end
    % take also the mean of highest ten percentile
    [ds,l] = sort(d);
    mean_k(i) = mean(ds(1:modelk));
end
%rewrite the last choosing of parameters
fk_score = 1 - model.beta*mean_k/ktup;
max_score = max(fk_score);
thrsh_score = (1-model.alpha)*max_score;
lc = find(fk_score >= thrsh_score);
if isempty(lc)
    pos = nan;
    combined_score = nan;
    edist_score = nan;
    win_score = nan;
    return
end
% now compute two stage scores
twostg_score = win_score_2stagei(model,seqsi,anti_indsi,bulges1i,bulges2i,endbulgesi);
twostg_score = interpolate_nan(twostg_score,endbulgesi);
combined_score = gamma*fk_score(lc) + (1-gamma)*twostg_score(lc);
[max_combined, imx] = max(combined_score);
pos = lc(imx);
combined_score = max_combined;
edist_score = fk_score(pos);
win_score = twostg_score(pos);
return
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function score_interp = interpolate_nan(score, endbulgesi);
% fill all NaNs which are surrounded by numeric values by interpolation
lb = find(endbulgesi);
score(lb) = 0;
A = find(isnan(score));
B = find(~isnan(score));
score_interp = zeros(size(score));
score_interp(B) = score(B);
score_interp(A) = interp1(B,score(B),A);
score_interp(find(isnan(score_interp))) = 0;
score_interp = score_interp';
return
function win_mirpos = get_win_pos_v1(mfes,anti_inds,mirpos,mirlen)

```

```

% function win_mirpos = get_win_pos(mfes,anti_inds,mirpos,mirlen)
% returns win_mirpos in index of basepair (from legs not loop).
% i.e. mfe(win_mirpos,1) is the nuc pos on the 5 arm
% for mir on arm3 returns the closest bp from its mirpos towards the legs
% for mir on arm5 returns the closest bp from its END (mirpos+mirlen-1) towards the legs
% also towards the legs
for i=1:length(mirpos)
    pos5 = mirpos(i);
    pos3 = pos5+mirlen(i)-1;
    mfe = mfes{i};
    arm5 = mfe(:,1);
    arm3 = mfe(:,2);
    eb_start = arm5(end)+1;
    eb_end = arm3(end)-1;
    eb_len = eb_end-eb_start+1;
    side5 = (pos5<eb_start);
    ai = anti_inds{i};
    is_paired = (ai~=0);
    if(side5)
        k=0;
        while(~is_paired(pos3-k))
            k=k+1;
        end
        win_mirpos(i) = find(arm5==(pos3-k));
    else
        k=0;
        while(~is_paired(pos5+k))
            k=k+1;
        end
        win_mirpos(i) = find(arm3==(pos5+k));
    end
    if isempty(win_mirpos(i))
        error('get_win_pos: fatal error. aborting.');
```

```

end
end

function strseq = int2nuc(intseq, ncase)
%strseq = int2nuc(intseq, ncase)
%convert a sequence of '1 2 3 4' into 'A C T G' or 'a c t g'
% ncase = uppercase | lowercase
if(isletter(intseq(1)))
    strseq = intseq;
    return;
end
if nargin == 1
    ncase = 'uppercase';
end
if strcmp(ncase,'uppercase')
    nucs = 'ACTG';
elseif strcmp(ncase,'lowercase')
    nucs = 'actg';

```

```

end
strseq = char(size(intseq));
for i = 1:length(intseq)
    strseq(i) = nucs(intseq(i));
end
return
function [yside, yprec2] = interpolate_prob_new(score, fitfile);
%[yside, yprec2] = interpolate_prob_new(score, fitfile);
% load the parameters for interpolation
load(fitfile);
%interpolate
yside = interp1(xs,ys,score,'linear');
yprec2 = interp1(xp2,yp2,score,'linear');
% extrapolate if necessary
if(min(xs)==xs(1)) % x is increasing
    yside(score<xs(1)) = ys(1);
    yprec2(score<xp2(1)) = yp2(1);
    yside(score>xs(end)) = ys(end);
    yprec2(score>xp2(end)) = yp2(end);
else % x is decreasing
    yside(score>xs(1)) = ys(1);
    yprec2(score>xp2(1)) = yp2(1);
    yside(score<xs(end)) = ys(end);
    yprec2(score<xp2(end)) = yp2(end);
end
returnfunction [mean_dist,std_dist] = loopdist_bp_model_normal(win_pos,mfes)
for i=1:length(win_pos)
    n_bps = size(mfes{i},1);
    loopdist(i) = n_bps - win_pos(i);
end
% cut off outliers
lp = prctile(loopdist,[2.5 97.5]);
l = find(loopdist >= lp(1) & loopdist <=lp(2));
mean_dist = mean(loopdist(l));
std_dist = std(loopdist(l));
%figure;hist(loopdist,[0:max(loopdist+1)]);title('loopdist training');function [pos_est,score,edist_score,win_score] =
mfold_cv_members(mirseq,mirpos,mirlen,palseq,anti_inds,bulges1,bulges2,...
    endbulges,clust_num,mfold,model_params);
%[pos_est,score,edist_score,win_score] =
mfold_cv_members(mirseq,mirpos,mirlen,palseq,anti_inds,bulges1,bulges2,...
% endbulges,clust_num,mfold,model_params);
n_all = length(palseq);
pos_est = zeros(0);
score =zeros(0);
model = model_params;
clust_list = unique(clust_num);
num_clusts = length(clust_list)
bins = round(0:num_clusts/mfold:num_clusts)
for m=1:mfold
    disp(['m= ' num2str(m)]);

```

```

bs_clusts = clust_list([bins(m)+1: bins(m+1)]);
bs = []; % test set
for i=1:length(bs_clusts)
    this_clust = bs_clusts(i);
    bs = [bs;find(clust_num==this_clust)];
end
disp(['size test set: ' num2str(size(bs))]);
bt = setdiff(1:n_all, bs);% train set

disp('building model...');
% learn model , and add all known mirs to it
model = bayes_learn_win(palseq(bt),anti_inds(bt),bulges1(bt),bulges2(bt),endbulges(bt), ...
    mirpos(bt),mirlen(bt),model);
clear seqsd_train;
for i = 1:length(bt); seqsd_train{i} = mirseq{bt(i)}(1:model.ktup); end
model.seqsd = transform_format(seqsd_train);

disp('predicting...');
[pos_est_m,score_m,edist_score_m,win_score_m] = firstkpp_predict_combined...
    (model, palseq(bs),anti_inds(bs),bulges1(bs),bulges2(bs),endbulges(bs));
pos_est(bs) = pos_est_m;
score(bs) = score_m;
edist_score(bs) = edist_score_m;
win_score(bs) = win_score_m;
end
returnfunction [pos_est,score,edist_score,win_score] =
mfold_cv_random(mirseq,mirpos,mirlen,palseq,anti_inds,bulges1,bulges2,...
    endbulges,mfold,randstate,model_params,permute);
%[pos_est,score,edist_score,win_score] =
mfold_cv_random(mirseq,mirpos,mirlen,palseq,anti_inds,bulges1,bulges2,...
% endbulges,mfold,randstate,model_params,permute);
if(~exist('permute'))
    permute = 1;
end
n_all = length(palseq);
bins = round(0:n_all/mfold:n_all)
bins_all = 1:n_all;
if permute
    rand('state',randstate);
l = randperm(n_all);
mirseq = mirseq(l);
mirpos = mirpos(l);
mirlen = mirlen(l);
palseq = palseq(l);
anti_inds = anti_inds(l);
bulges1 = bulges1(l);
bulges2 = bulges2(l);
endbulges = endbulges(l);
end
pos_est = zeros(0);

```

```

edist_score=zeros(0);
win_score=zeros(0);
model=model_params;
m=1;
while m <= mfold
    bs=[bins(m)+1:bins(m+1)];% test set
    bt=setdiff(bins_all,bs);% train set

    disp(['m = ' num2str(m)]);

    disp('building model...');
    % learn model , and add all known mirs to it
    model=bayes_learn_win(palseq(bt),anti_inds(bt),bulges1(bt),bulges2(bt),endbulges(bt), ...
        mirpos(bt),mirlen(bt),model);
    clear seqsd_train;
    for i=1:length(bt); seqsd_train{i}=mirseq{bt(i)}(1:model.ktup); end
    model.seqsd=transform_format(seqsd_train);
    disp('predicting...');
    [pos_est_m,score_m,edist_score_m,win_score_m]=firstkpp_predict_combined...
        (model,palseq(bs),anti_inds(bs),bulges1(bs),bulges2(bs),endbulges(bs));
    pos_est(bs)=pos_est_m;
    score(bs)=score_m;
    edist_score(bs)=edist_score_m;
    win_score(bs)=win_score_m;

    m=m+1;
end
if permute
    % undo the permutation
    pos_est(l)=pos_est;
    score(l)=score;
    edist_score(l)=edist_score;
    win_score(l)=win_score;
end
returnfunction [intseq,fault_seq]=nuc2int(strseq);
%[intseq,fault_seq]=nuc2int(strseq)
%convert a sequence of 'A C T G' into a array of 1 2 3 4
if(~isletter(strseq(1)))
    intseq=strseq;
    fault_seq=0;
    return;
end
intseq=zeros(size(strseq));
fault_seq=0;
for i=1:length(strseq)
    switch upper(strseq(i))
        case 'A' , intseq(i)=1;
        case 'C' , intseq(i)=2;
        case 'T' , intseq(i)=3;
        case 'G' , intseq(i)=4;
    end
end

```

```

        otherwise , intseq = []; fault_seq = 1; break;
    end
end
function [num_bps_vals,num_bps_ps] = num_bps_model_hist_list(mfes,anti_inds,model,wps)
numseqs = length(wps);
if(numseqs~=length(mfes) | numseqs~=length(anti_inds))
    error('number of seqs differs from length(wps)');
end
% transform wps into cell if it is not so.
if(~iscell(wps))
    for i=1:numseqs
        tt{i} = wps(i);
    end
    wps = tt;
end
beta = 0.5;
win_len = model.ds_win_len;
num_bps = [];
for i=1:numseqs
    wp_list = wps{i};
    mfe = mfes{i};
    ai = anti_inds{i};
    is_paired = (ai~=0);
    for k=1:length(wp_list)
        wp = wp_list(k);
        pos3_on_arm5 = mfe(wp,1);
        pos5_on_arm3 = mfe(wp,2);
        pos5_on_arm5 = max(1,pos3_on_arm5-win_len+1);
        pos3_on_arm3 = min(length(ai),pos5_on_arm3+win_len-1);
        numpaired5 = sum(is_paired(pos5_on_arm5:pos3_on_arm5));
        numpaired3 = sum(is_paired(pos5_on_arm3:pos3_on_arm3));
        num_bps = [num_bps,min(numpaired5,numpaired3)];
    end
end
num_bps_vals = 0:model.win_num_bins_num_bps-1;
n = hist(num_bps,num_bps_vals);
n = n+beta;
num_bps_ps = n/sum(n);
%figure;bar(num_bps_vals,num_bps_ps);title('numbps hist training');
model_params.trained_on = 'hmdcc440';
% see files with this extension for the training data itself
%specific firstk parameters
model_params.ktup = 8; % window size for edist part
model_params.k = 4; % number of nearest neighbors in KNN
model_params.alpha = 0.25; %fraction best score that defines the region for ranking with 2stage
model_params.beta = 2; %scaling parameter: score = 1-beta*mean_k/ktup;
model_params.gamma = 0.75; % the weight of the first (edist) score in combined score
% win params
model_params.min_win_len = 17; % single starnded min win len in nts.
model_params.ds_win_len = 22; % double starnded win len in nts.

```

```

model_params.use_mirlen_in_learning_win = 0; % if 1 uses mirlen else uses win_len in learning win
model_params.win_base_pair_states = 6; % this param is used only for win prediction.
model_params.win_bulge = 0; % for win prediction. which bulges to look at. 1/2 - bulges1/2, else total
model_params.win_num_bins_sym = model_params.ds_win_len;
model_params.win_num_bins_num_bps = model_params.ds_win_len;
model_params.win_use_loopdist = 1;
model_params.win_use_win_sym = 1;
model_params.win_use_pos_bulge = 1;
model_params.win_use_num_bps = 1;
model_params.win_use_base_pair = 0;
function [seqs,anti_inds,bulges_nonsym,bulges_sym,endbulges,pal_id,energy,all_pal_ids] =
read_structure_with_id_fid(fid,seqtot)
% function [seqs,anti_inds,bulges_nonsym,bulges_sym,endbulges,pal_id,energy,all_pal_ids] =
read_structure_with_id_fid(fid,seqtot)
% same as read_structure_withanti_fid but reads file that have before the 4 line zucker draw
% a line giving the pal_id and a line giving the energy.
% all_pal_ids is all ids read from file, whether faulty or not
% new feature: checks that draw is not messed up and if it is gives faulty seq.
Mxplen = 250; % maximal length of palindrom
counter = 0;
seq_no = 0;
seqs = cell(0);
bulges_nonsym= cell(0);
bulges_sym= cell(0);
endbulges = cell(0);
pal_id = zeros(0);
energy = zeros(0);
while ~feof(fid) & seq_no < seqtot
    this_pal_id = str2double(fgetl(fid));
    this_energy = str2double(fgetl(fid));
    structure = char(4,250);
    i = 0;
    line = fgetl(fid);
    if isempty(line)
        line = 'emptyline';
        fault_seq_emptyline = 1;
    else
        fault_seq_emptyline = 0;
    end
    while(line(1)~= '|') % if emptyline this is always true so will go into loop
        i = i+1;
        structure(i,1:length(line)) = line;
        line = fgetl(fid);
        if isempty(line)
            line = 'emptyline';
            fault_seq_emptyline = 1;
        end
    end
end
if(i~=4)
    fault_seq_numlines = 1;

```

```

else
    fault_seq_numlines = 0;
end

fault_seq_struct = 1; % guilty until proven innocent
fault_seq_nuc = 1;
if(fault_seq_numlines == 0 & fault_seq_emptyline==0)
    [seqi, anti_indi, bulge1i, bulge2i, endbulgei,fault_seq_struct] = get_features(structure);
    if(fault_seq_struct==0)
        % this is the old bulge1 and bulge2, now need to correct that
        bulge_nonsymi=bulge1i;
        bulge_symi=bulge2i;
        for j = 1:length(seqi)
            if(bulge_nonsymi(j))
                if(bulge_symi(max(1,j-1))) % a neighbor has a bulgesym flag on
                    bulge_symi(j) = 1;
                    bulge_nonsymi(j) = 0;
                end
            end
        end
        for j = length(seqi):-1:1
            if(bulge_nonsymi(j))
                if(bulge_symi(min(j+1,length(seqi)))) % a neighbor has a bulgesym flag on
                    bulge_symi(j) = 1;
                    bulge_nonsymi(j) = 0;
                end
            end
        end
        [intseq, fault_seq_nuc] = nuc2int(seqi);
    end
end

if (fault_seq_struct == 0 & fault_seq_nuc == 0 & fault_seq_numlines == 0 & fault_seq_emptyline == 0)
    seq_no = seq_no + 1;
    seqs{seq_no} = intseq;
    anti_inds{seq_no} = anti_indi;
    bulges_nonsym{seq_no} = bulge_nonsymi;
    bulges_sym{seq_no} = bulge_symi;
    endbulges{seq_no} = endbulgei;
    pal_id(seq_no) = this_pal_id;
    energy(seq_no) = this_energy;
    counter = counter + 1;
    all_pal_ids(counter) = this_pal_id;
else
    disp(['faulty seq on pal id ' num2str(this_pal_id)])
    if(fault_seq_emptyline)
        disp(['reason is that there was an empty line in zucker']);
    elseif(fault_seq_numlines)
        disp(['reason is that there were not 4 lines in the draw']);
    elseif(fault_seq_struct)

```

```

        disp(['reason is that draw was messed has nuc in pair and bulge at the same time']);
elseif(fault_seq_nuc)
    disp(['reason is that there was an illegal letter in the seq']);
end
counter = counter + 1;
all_pal_ids(counter) = this_pal_id;
end
end
return
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [seq, anti_ind, bulge1, bulge2, endbulge, fault_seq] = get_features(structure)
% get sequence as well as bulge structure
fault_seq = 0;
%upper half (5' side)
bulge_row = 1; % the row of bulge letters
bulge_row_opposite = 4;
uphalf = structure(1:2,:);
[j,k] = find(isletter(uphalf));
max_col = max(k);
tmpmat = zeros(2,max_col);
count = 0;
for col = 1: max_col
    fl = find(isletter(uphalf(:,col)));
    if (length(fl)>1);
        fault_seq = 1;
        seq=nan;anti_ind=nan;bulge1=nan;bulge2=nan;endbulge=nan;
        return;
    end;
    if ~isempty(fl)
        count = count + 1;
        seq(count) = uphalf(fl,col);
        bulge = (fl == bulge_row);
        if(bulge)
            tmpmat(1,col) = 0;
        else
            tmpmat(1,col) = count;
        end
        bulge1(count) = 0;
        bulge2(count) = 0;
        if bulge & isletter(structure(bulge_row_opposite,col))
            bulge2(count) = 1;
        elseif bulge & ~isletter(structure(bulge_row_opposite,col))
            bulge1(count) = 1;
        end
    end
end
end
% endbulge is coded on the upper half
% go backwards from 3' side to 5' side
endbulge = zeros(size(bulge1));

```

```

lwhalf = structure(3:4,:);
pos = length(bulge1);
while bulge1(pos) == 1
    endbulge(pos) = 1;
    bulge1(pos) = 0;
    pos = pos - 1;
end
%lower half
bulge_row = 2; % 4 th line on structure is 2 line on lower half
bulge_row_opposite = 1;
[j,k] = find(isletter(lwhalf));
max_col = max(k);
for col = max_col:-1:1
    fl = find(isletter(lwhalf(:,col)));
    if ~isempty(fl)
        count = count + 1;
        seq(count) = lwhalf(fl,col);
        bulge = (fl == bulge_row);
        if(bulge)
            tmpmat(2,col) = 0;
        else
            tmpmat(2,col) = count;
        end
        bulge1(count) = 0;
        bulge2(count) = 0;
        if bulge & isletter(structure(bulge_row_opposite,col))
            bulge2(count) = 1;
        elseif bulge & ~isletter(structure(bulge_row_opposite,col))
            bulge1(count) = 1;
        end
        endbulge(count) = 0;
    end
end
anti_ind = zeros(size(bulge1));
for col=1:max_col
    if(tmpmat(1,col))
        anti_ind(tmpmat(1,col)) = tmpmat(2,col);
        anti_ind(tmpmat(2,col)) = tmpmat(1,col);
    end
end
return
function run_firstkpp(infile, outfile)
%run_firstkpp(infile, outfile)
model_filename = 'model_hmdcc440_params1.mat';
fitfile = 'fitfile_hmdcc440_params1_mfold5_proto5.mat';
fidin = fopen(infile,'r');
fidout = fopen(outfile,'a');
seqstot = 1000; %number of sequences to classify each loop
load(model_filename);
while ~feof(fidin)

```

```

disp('reading structure...');
[palseq,anti_inds,bulges1,bulges2,endbulges,pal_id,energy,all_pal_ids] = ...
    read_structure_with_id_fid(fidin,seqstot);
mfes = anti_inds_to_mfe(anti_inds);
[pos_est,score,edist_score,win_score] = ...
    firstkpp_predict_combined(model,palseq,anti_inds,bulges1,bulges2,endbulges);
[yside, yprec2] = interpolate_prob_new(score, fitfile);
res = [pal_id; pos_est; score; yprec2; edist_score; win_score];
fprintf(fidout, '%d %d %g %g %g %g\n', res);
end
fclose(fidin);
fclose(fidout);
param_file='params1'; params1;
model = model_params;
model.param_file = param_file;
set_name = model_params.trained_on;
fid = fopen(['zucker_draw_' set_name '.txt'],'r');
[palseq,anti_inds,bulges1,bulges2,endbulges,pal_id,energy,all_pal_ids] = ...
    read_structure_with_id_fid(fid,1000);
fclose(fid);
if(length(pal_id)~=length(all_pal_ids))
    error('in training data do not allow faulty seqs, take out of there');
end
mfes = anti_inds_to_mfe(anti_inds);
fname = ['mirseq_' set_name '.txt'];
[mirseq,mirlen] = read_seq_with_id(fname);
mirpos = locate_dicer(mirseq,palseq);
extension = [set_name '_params1'];
maxd = 5;
mfold = 5;
extension_proto = [set_name '_params1_mfold5_proto5'];
randstate = 1;
extension_random = [set_name '_params1_mfold5_randstate1'];
disp('building model from all data and saving it....')
% learn model , and add all known mirs to it
model = bayes_learn_win(palseq,anti_inds,bulges1,bulges2,endbulges,mirpos,mirlen,model);
% take the first ktup nucleotides of every miR
for i = 1:length(mirseq); mirseq{i} = mirseq{i}(1:model.ktup); end
model.seqs_d = transform_format(mirseq);
eval(['save model_' extension '.mat model']);
%%%%%%%%%%%%%%
%%%%%%%%%%
%%%%%%%%%% random mfold %%%%%%%%%%%
if(1)
disp('doing random mfold cv....')
[pos_est,score,edist_score,win_score] = mfold_cv_random(mirseq,mirpos,mirlen,palseq,anti_inds,...
    bulges1,bulges2,endbulges,mfold,randstate,model_params,1);
figure
subplot(2,1,1)
res = analyse_errors_perc(pos_est,score,mirpos,endbulges);

```

```

a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
subplot(2,1,2)
if(~exist('num_bins'))
    num_bins = 6;
end
[xs,ys,yp2,yp2] = analyse_errors_bins2(pos_est,score,mirpos,endbulges,num_bins);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
eval(['print -djpeg ' extension_random '.jpeg']);
eval(['save fitfile_' extension_random '.mat xs ys xp2 yp2']);
figure;
fid = fopen(['info_and_criteria_' extension_random '.txt'],'w');
thresh_vec = [0:0.01:1];
clf;[thresh,acc2,captures] = analyse_errors_thresh_B(pos_est,score,mirpos,endbulges,thresh_vec);
grid
legend('off')
fprintf(fid,'%sthresh\tacc2\tcaptures\r\n');
for i=1:length(thresh)
    fprintf(fid,'%1.4f\t%1.4f\t%d\r\n',thresh(i),acc2(i),captures(i));
end
fclose(fid);
%save mfold results for each pal individually
fitfile = ['fitfile_' extension_random];
[yside,yprec2] = interpolate_prob_new(score, fitfile);
fid = fopen(['all_pal_res_' extension_random '.txt'],'w');
fprintf(fid,'%pal_id\treal_mirpos\tfirstkpp_pos\tfirstkpp_score\typrec2\tfirstkpp_edist_score\tfirstk++_win_score\r\n');
fprintf(fid,'%-----\r\n');
palres = [pal_id; mirpos; pos_est; score; yprec2; edist_score; win_score];
fprintf(fid, '%d %d %d %g %g %g %g\r\n', palres);
fclose(fid);
end
%%%%%%%%%%%%%%
%%%%%%%%%%%%%%
%%%%%%%%%%%%%% memebbers mfold %%%%%%%%%%
if(1)
disp('doing proto cv....')
filename =['clust_proto_members_' num2str(maxd) '_' set_name '.txt'];
clust_num = load(filename);
if length(clust_num) ~= length(palseq)
    error('clust_num wrong size');
end
[pos_est,score,edist_score,win_score] = mfold_cv_members(mirseq,mirpos,mirlen,palseq,anti_inds,...
    bulges1,bulges2,endbulges,clust_num,mfold,model_params);
figure
subplot(2,1,1)
res = analyse_errors_perc(pos_est,score,mirpos,endbulges);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
subplot(2,1,2)

```

```

if(~exist('num_bins'))
    num_bins = 6;
end
[xs,ys,xp2,yp2] = analyse_errors_bins2(pos_est,score,mirpos,endbulges,num_bins);
a=axis; a(3)=0; a(4)=1; axis(a); grid;
legend('off')
eval(['print -djpeg ' extension_proto '.jpeg']);
eval(['save fitfile_ ' extension_proto '.mat xs ys xp2 yp2']);
figure;
fid = fopen(['info_and_criteria_ ' extension_proto '.txt'],'w');
thresh_vec = [0:0.01:1];
clf;[thresh,acc2,captures] = analyse_errors_thresh_B(pos_est,score,mirpos,endbulges,thresh_vec);
grid
legend('off')
fprintf(fid,'%s\tthresh\tacc2\tcaptures\n',thresh_vec);
for i=1:length(thresh_vec)
    fprintf(fid,'%1.4f\t%1.4f\t%d\n',thresh_vec(i),acc2(i),captures(i));
end
fclose(fid);
%save mfold results for each pal individually
fitfile = ['fitfile_ ' extension_proto];
[yside, yprec2] = interpolate_prob_new(score, fitfile);
fid = fopen(['all_pal_res_ ' extension_proto '.txt'],'w');
fprintf(fid,'%s\tpal_id\treal_mirpos\tfirstkpp_pos\tfirstkpp_score\typrec2\tfirstkpp_edist_score\tfirstk++_win_score\n');
fprintf(fid,'%s\t-----\n');
palres = [pal_id; mirpos; pos_est; score; yprec2; edist_score; win_score];
fprintf(fid, '%d %d %d %g %g %g %g\n', palres);
fclose(fid);
end
function seqs = transform_format(seqs,format);
%seqs = transform_format(seqs,format);
% format is either 'int' or 'nuc'
%if format not given, toggle format from int<-> nuc
% note that assume all seqs are in same format initially
if(nargin==1)
    if all(isletter(seqs{1}))
        format = 'int';
    else
        format = 'nuc';
    end
end
end
if(strcmp(format,'nuc'))
    for i = 1:length(seqs)
        seqs{i} = int2nuc(seqs{i});
    end
elseif(strcmp(format,'int'))
    for i = 1:length(seqs)
        seqs{i} = nuc2int(seqs{i});
    end
end

```

```

else
    error('transform_format: format (if given) must be int or nuc');
end
return

function [p_bp_arm5,p_bp_arm3] = win_base_pair_model_list(mfes,anti_inds,seqs,model,wps)
numseqs = length(wps);
if(numseqs~=length(mfes) | numseqs~=length(anti_inds) | numseqs~=length(seqs))
    error('number of seqs differs from length(wps)');
end
% transform wps into cell if it is not so.
if(~iscell(wps))
    for i=1:numseqs
        tt{i} = wps(i);
    end
    wps = tt;
end
win_len = model.ds_win_len;
base_pair_states = model.win_base_pair_states;
c_bp_arm5 = zeros(1,base_pair_states);
c_bp_arm3 = zeros(1,base_pair_states);
seqsbp = nuc2bp(seqs,anti_inds,base_pair_states);
for i = 1:numseqs
    wp_list = wps{i};
    mfe = mfes{i};
    ai = anti_inds{i};
    is_paired = (ai~=0);
    for k=1:length(wp_list)
        wp = wp_list(k);
        pos3_on_arm5 = mfe(wp,1);
        pos5_on_arm3 = mfe(wp,2);
        pos5_on_arm5 = max(1,pos3_on_arm5-win_len+1);
        pos3_on_arm3 = min(length(ai),pos5_on_arm3+win_len-1);
        for j = 1:base_pair_states
            c_bp_arm5(j) = c_bp_arm5(j)+sum(seqsbp{i}(pos5_on_arm5:pos3_on_arm5) == j);
            c_bp_arm3(j) = c_bp_arm3(j)+sum(seqsbp{i}(pos5_on_arm3:pos3_on_arm3) == j);
        end
    end
end
p_bp_arm5 = c_bp_arm5/sum(c_bp_arm5);
p_bp_arm3 = c_bp_arm3/sum(c_bp_arm3);
function [pb_arm5,pb_arm3,pb1_arm5,pb1_arm3,pb2_arm5,pb2_arm3] = ...
    win_bulge_pos_model_list(mfes,bulges1,bulges2,model,wps)
% on both sides of window from loop end of window
% pb1 - for bulges1 pb2 - for bulges2 pb - for total
win_len = model.ds_win_len;
numseqs = length(wps);
if(numseqs~=length(mfes) | numseqs~=length(bulges1) | numseqs~=length(bulges2))
    error('number of seqs differs from length(wps)');
end

```

```

% transform wps into cell if it is not so.
if(~iscell(wps))
    for i=1:numseqs
        tt{i} = wps(i);
    end
    wps = tt;
end
for i=1:numseqs
    wp_list = wps{i};
    mfe = mfes{i};
    bulges{i} = bulges1{i}+bulges2{i};
    inds5_i = cell(0);
    inds3_i = cell(0);
    for k=1:length(wp_list)
        wp = wp_list(k);
        pos3_on_arm5 = mfe(wp,1);
        pos5_on_arm3 = mfe(wp,2);
        pos5_on_arm5 = max(1,pos3_on_arm5-win_len+1);
        pos3_on_arm3 = min(length(bulges{i}),pos5_on_arm3+win_len-1);
        inds5_i{k} = pos3_on_arm5:-1:pos5_on_arm5; % always start from loop side
        inds3_i{k} = pos5_on_arm3:pos3_on_arm3;
    end
    inds5{i} = inds5_i;
    inds3{i} = inds3_i;
end
pb_arm5 = bulge_positional_list(model,bulges,inds5);
pb_arm3 = bulge_positional_list(model,bulges,inds3);
pb1_arm5 = bulge_positional_list(model,bulges1,inds5);
pb1_arm3 = bulge_positional_list(model,bulges1,inds3);
pb2_arm5 = bulge_positional_list(model,bulges2,inds5);
pb2_arm3 = bulge_positional_list(model,bulges2,inds3);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function p = bulge_positional_list(model,bulges,inds)
win_len = model.ds_win_len;
c = zeros(win_len,2);
p = zeros(win_len,1);
for i = 1:length(bulges)
    bulgesi = bulges{i};
    for k = 1:length(inds{i})
        this_inds = inds{i}{k};
        for j=1:length(this_inds)
            this_ind = this_inds(j);
            c(j,1) = c(j,1) + bulgesi(this_ind);
            c(j,2) = c(j,2) + (1-bulgesi(this_ind));
        end
    end
end
for j = 1:win_len
    p(j) = c(j,1)/sum(c(j,:));
end

```

```

end
function pos_scorei = win_score_2stagei(model,seqsi,anti_indsi,bulges1i,bulges2i,endbulgesi)
%function pos_scorei = win_score_2stagei(model,seqsi,anti_indsi,bulges1i,bulges2i,endbulgesi);
% pos_score is a vector having the length of the ith pal. pos_scorei(j) is the
% score of the window which gives that position of the pal. The entry is
% NULL if no window produces that pos5 or if it is on a loop. Note that each
% double stranded window gives two pos5, one on each arm, and they both have the same
% score - that of the ds_win.
mfeisi = anti_inds_to_mfe(anti_indsi);
pos_scorei = get_pos_scores(model,seqsi,mfeisi,anti_indsi,bulges1i,bulges2i,endbulgesi);
return
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function pos_scores = get_pos_scores(model,seqsi,mfei,ai,bulges1i,bulges2i, endbulgesi);
pos_scores = nan * ones(1,length(seqsi)); % initially all nan
p_mir = ones(1,size(mfei,1));
p_nonmir = ones(1,size(mfei,1));
wp_scores = nan * ones(1,size(mfei,1)); % in base pairs
if(model.win_use_loopdist)
    p_loopdist = loopdist_bp_prob_normal(model,mfei);
    p_mir = p_mir.*p_loopdist;
    p_nonmir = p_nonmir.*(1-p_loopdist);
end
if(model.win_use_num_bps)
    [p_num_bps_mir,p_num_bps_nonmir] = num_bps_prob_hist(model,mfei,ai);
    p_mir = p_mir.*p_num_bps_mir;
    p_nonmir = p_nonmir.*p_num_bps_nonmir;
end
if(model.win_use_win_sym)
    [p_win_sym_mir,p_win_sym_nonmir] = win_sym_prob(model,mfei,ai);
    p_mir = p_mir.*p_win_sym_mir;
    p_nonmir = p_nonmir.*p_win_sym_nonmir;
end
if(model.win_use_pos_bulge)
    [p_pos_bulge_mir,p_pos_bulge_nonmir] = win_bulges_pos_prob(model,mfei,bulges1i,bulges2i,0);
    p_mir = p_mir.*p_pos_bulge_mir;
    p_nonmir = p_nonmir.*p_pos_bulge_nonmir;
end
if(model.win_use_base_pair)
    [p_base_pair_mir,p_base_pair_nonmir] = win_base_pair_prob(model,mfei,ai,seqsi);
    p_mir = p_mir.*p_base_pair_mir;
    p_nonmir = p_nonmir.*p_base_pair_nonmir;
end
I = find((p_mir + p_nonmir) > 0);
wp_scores(I) = p_mir(I)./(p_mir(I)+p_nonmir(I));
% now transfer each of the win scores to the positions scores
for wp=1:length(wp_scores)
    s = wp_scores(wp);
    if(~isnan(s))
        pos3_on_arm5 = mfei(wp,1);
    end
end

```

```

pos5_on_arm3 = mfe(wp,2);
pos5_on_arm5 = max(1,pos3_on_arm5-model.ds_win_len+1);
pos_scores(pos5_on_arm3) = s;
pos_scores(pos5_on_arm5) = s;
end
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function p_loopdist = loopdist_bp_prob_normal(model,mfe);
n_bps = size(mfe,1);
wp = 1:n_bps;
zloopdist = ((n_bps - wp) - model.mean_loopdist_bp)/model.std_loopdist_bp;
p_loopdist = exp(-0.5*zloopdist.^2);
p_loopdist = p_loopdist/sum(p_loopdist);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [p_num_bps_mir,p_num_bps_nonmir] = num_bps_prob_hist(model,mfe,ai);
win_len = model.ds_win_len;
n_bps = size(mfe,1);
p_num_bps_mir = zeros(1,n_bps);
p_num_bps_nonmir = zeros(1,n_bps);
is_paired = (ai~=0);
for wp = 1:n_bps
    pos3_on_arm5 = mfe(wp,1);
    pos5_on_arm3 = mfe(wp,2);
    pos5_on_arm5 = max(1,pos3_on_arm5-win_len+1);
    pos3_on_arm3 = min(length(ai),pos5_on_arm3+win_len-1);
    win5inds = pos5_on_arm5:pos3_on_arm5;
    win3inds = pos5_on_arm3:pos3_on_arm3;
    if((length(win5inds)>=model.min_win_len) & (length(win3inds)>=model.min_win_len))
        numpaired5 = sum(is_paired(win5inds));
        numpaired3 = sum(is_paired(win3inds));
        num_bps_i = min(numpaired5,numpaired3);
        % mir
        tt = find(model.win_num_bps_mir_vals == num_bps_i);
        if(tt)
            p_num_bps_mir_i = model.win_num_bps_mir_ps(tt);
        else
            p_num_bps_mir_i = 0;
        end
        p_num_bps_mir_i = p_num_bps_mir_i*(win_len/mean(length(win5inds),length(win3inds)));
        p_num_bps_mir(wp) = p_num_bps_mir_i;
        % nonmir
        tt = find(model.win_num_bps_nonmir_vals == num_bps_i);
        if(tt)
            p_num_bps_nonmir_i = model.win_num_bps_nonmir_ps(tt);
        else
            p_num_bps_nonmir_i = 0;
        end
        p_num_bps_nonmir_i = p_num_bps_nonmir_i*(win_len/mean(length(win5inds),length(win3inds)));
    end
end

```

```

    p_num_bps_nonmir(wp) = p_num_bps_nonmir_i;
end
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [p_win_sym_mir,p_win_sym_nonmir] = win_sym_prob(model,mfe,ai);
win_len = model.ds_win_len;
n_bps = size(mfe,1);
p_win_sym_mir = zeros(1,n_bps);
p_win_sym_nonmir = zeros(1,n_bps);
is_paired = (ai~=0);
for wp = 1:n_bps
    pos3_on_arm5 = mfe(wp,1);
    pos5_on_arm3 = mfe(wp,2);
    pos5_on_arm5 = max(1,pos3_on_arm5-win_len+1);
    pos3_on_arm3 = min(length(ai),pos5_on_arm3+win_len-1);
    win5inds = pos5_on_arm5:pos3_on_arm5;
    win3inds = pos5_on_arm3:pos3_on_arm3;
    if((length(win5inds)>=model.min_win_len) & (length(win3inds)>=model.min_win_len))
        numunpaired5 = sum(~is_paired(win5inds));
        numunpaired3 = sum(~is_paired(win3inds));
        win_sym_i = abs(numunpaired5-numunpaired3);
        % mir
        tt = find(model.win_sym_mir_vals == win_sym_i);
        if(tt)
            p_win_sym_mir_i = model.win_sym_mir_ps(tt);
        else
            p_win_sym_mir_i = 0;
        end
        p_win_sym_mir_i = p_win_sym_mir_i*sqrt(win_len/mean(length(win5inds),length(win3inds)));
        p_win_sym_mir(wp) = p_win_sym_mir_i;
        % nonmir
        tt = find(model.win_sym_nonmir_vals == win_sym_i);
        if(tt)
            p_win_sym_nonmir_i = model.win_sym_nonmir_ps(tt);
        else
            p_win_sym_nonmir_i = 0;
        end
        p_win_sym_nonmir_i = p_win_sym_nonmir_i*sqrt(win_len/mean(length(win5inds),length(win3inds)));
        p_win_sym_nonmir(wp) = p_win_sym_nonmir_i;
    end
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [p_pos_bulge_mir,p_pos_bulge_nonmir] = win_bulges_pos_prob(model,mfe,bulges1i,bulges2i,use_avg);
bulge_flag = model.win_bulge;
win_len = model.ds_win_len;
n_bps = size(mfe,1);
p_pos_bulge_mir = zeros(1,n_bps);
p_pos_bulge_nonmir = zeros(1,n_bps);

```

```

pb_arm5_mir = model.win_bulge_posit_arm5_mir;
pb_arm3_mir = model.win_bulge_posit_arm3_mir;
pb1_arm5_mir = model.win_bulge1_posit_arm5_mir;
pb1_arm3_mir = model.win_bulge1_posit_arm3_mir;
pb2_arm5_mir = model.win_bulge2_posit_arm5_mir;
pb2_arm3_mir = model.win_bulge2_posit_arm3_mir;
pb_arm5_nonmir = model.win_bulge_posit_arm5_nonmir;
pb_arm3_nonmir = model.win_bulge_posit_arm3_nonmir;
pb1_arm5_nonmir = model.win_bulge1_posit_arm5_nonmir;
pb1_arm3_nonmir = model.win_bulge1_posit_arm3_nonmir;
pb2_arm5_nonmir = model.win_bulge2_posit_arm5_nonmir;
pb2_arm3_nonmir = model.win_bulge2_posit_arm3_nonmir;
if(use_avg)
    pb_mir = 0.5*(pb_arm5_mir+pb_arm3_mir);
    pb_arm5_mir = pb_mir;
    pb_arm3_mir = pb_mir;
    pb1_mir = 0.5*(pb1_arm5_mir+pb1_arm3_mir);
    pb1_arm5_mir = pb1_mir;
    pb1_arm3_mir = pb1_mir;
    pb2_mir = 0.5*(pb2_arm5_mir+pb2_arm3_mir);
    pb2_arm5_mir = pb2_mir;
    pb2_arm3_mir = pb2_mir;
    pb_nonmir = 0.5*(pb_arm5_nonmir+pb_arm3_nonmir);
    pb_arm5_nonmir = pb_nonmir;
    pb_arm3_nonmir = pb_nonmir;
    pb1_nonmir = 0.5*(pb1_arm5_nonmir+pb1_arm3_nonmir);
    pb1_arm5_nonmir = pb1_nonmir;
    pb1_arm3_nonmir = pb1_nonmir;
    pb2_nonmir = 0.5*(pb2_arm5_nonmir+pb2_arm3_nonmir);
    pb2_arm5_nonmir = pb2_nonmir;
    pb2_arm3_nonmir = pb2_nonmir;
end
if(bulge_flag == 1)
    pb_arm5_mir = pb1_arm5_mir;
    pb_arm3_mir = pb1_arm3_mir;
    pb_arm5_nonmir = pb1_arm5_nonmir;
    pb_arm3_nonmir = pb1_arm3_nonmir;
    bulgesi = bulges1i;
elseif(bulge_flag == 2)
    pb_arm5_mir = pb2_arm5_mir;
    pb_arm3_mir = pb2_arm3_mir;
    pb_arm5_nonmir = pb2_arm5_nonmir;
    pb_arm3_nonmir = pb2_arm3_nonmir;
    bulgesi = bulges2i;
else
    % just use the total pb.
    bulgesi = bulges1i+bulges2i;
end
for wp = 1:n_bps
    pos3_on_arm5 = mfe(wp,1);

```

```

pos5_on_arm3 = mfe(wp,2);
pos5_on_arm5 = max(1,pos3_on_arm5-win_len+1);
pos3_on_arm3 = min(length(bulgesi),pos5_on_arm3+win_len-1);
win5 = bulgesi(pos3_on_arm5:-1:pos5_on_arm5); % always start from loop side
win3 = bulgesi(pos5_on_arm3:pos3_on_arm3);
win5_len_actual = length(win5);
win3_len_actual = length(win3);
if((length(win5)>=model.min_win_len) & (length(win3)>=model.min_win_len))
    J0 = find(win5 == 0);
    J1 = find(win5);
    p_bulges5_mir_i = prod(pb_arm5_mir(J1)) * prod(1-pb_arm5_mir(J0));
    p_bulges5_mir_i = p_bulges5_mir_i^(win_len/win5_len_actual);
    p_bulges5_nonmir_i = prod(pb_arm5_nonmir(J1)) * prod(1-pb_arm5_nonmir(J0));
    p_bulges5_nonmir_i = p_bulges5_nonmir_i^(win_len/win5_len_actual);
    J0 = find(win3 == 0);
    J1 = find(win3);
    p_bulges3_mir_i = prod(pb_arm3_mir(J1)) * prod(1-pb_arm3_mir(J0));
    p_bulges3_mir_i = p_bulges3_mir_i^(win_len/win3_len_actual);
    p_bulges3_nonmir_i = prod(pb_arm3_nonmir(J1)) * prod(1-pb_arm3_nonmir(J0));
    p_bulges3_nonmir_i = p_bulges3_nonmir_i^(win_len/win3_len_actual);

    p_pos_bulge_mir(wp) = sqrt(p_bulges5_mir_i*p_bulges3_mir_i);
    p_pos_bulge_nonmir(wp) = sqrt(p_bulges5_nonmir_i*p_bulges3_nonmir_i);
end
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [p_base_pair_mir,p_base_pair_nonmir] = win_base_pair_prob(model,mfe,ai,seq);
win_len = model.ds_win_len;
base_pair_states = model.win_base_pair_states;
p_bp_arm5_mir = model.win_base_pair_arm5_mir;
p_bp_arm3_mir = model.win_base_pair_arm3_mir;
p_bp_arm5_nonmir = model.win_base_pair_arm5_nonmir;
p_bp_arm3_nonmir = model.win_base_pair_arm3_nonmir;
n_bps = size(mfe,1);
p_base_pair_mir = zeros(1,n_bps);
p_base_pair_nonmir = zeros(1,n_bps);
t1{1} = seq;
t2{1} = ai;
t3 = nuc2bp(t1,t2,base_pair_states);
seqbp = t3{1};
for wp = 1:n_bps
    pos3_on_arm5 = mfe(wp,1);
    pos5_on_arm3 = mfe(wp,2);
    pos5_on_arm5 = max(1,pos3_on_arm5-win_len+1);
    pos3_on_arm3 = min(length(ai),pos5_on_arm3+win_len-1);
    win5inds = (pos5_on_arm5:pos3_on_arm5);
    win3inds = (pos5_on_arm3:pos3_on_arm3);
    if((length(win5inds)>=model.min_win_len) & (length(win3inds)>=model.min_win_len))
        % mir

```

```

p5_mir_i = 1;
p3_mir_i = 1;
for j = 1:base_pair_states
    p5_mir_i = p5_mir_i * p_bp_arm5_mir(j)^sum(seqbp(win5inds) == j);
    p3_mir_i = p3_mir_i * p_bp_arm3_mir(j)^sum(seqbp(win3inds) == j);
end
p5_mir_i = p5_mir_i.^(win_len/length(win5inds));
p3_mir_i = p3_mir_i.^(win_len/length(win3inds));
p_base_pair_mir(wp) = sqrt(p5_mir_i*p3_mir_i);
% nonmir
p5_nonmir_i = 1;
p3_nonmir_i = 1;
for j = 1:base_pair_states
    p5_nonmir_i = p5_nonmir_i * p_bp_arm5_nonmir(j)^sum(seqbp(win5inds) == j);
    p3_nonmir_i = p3_nonmir_i * p_bp_arm3_nonmir(j)^sum(seqbp(win3inds) == j);
end
p5_nonmir_i = p5_nonmir_i.^(win_len/length(win5inds));
p3_nonmir_i = p3_nonmir_i.^(win_len/length(win3inds));
p_base_pair_nonmir(wp) = sqrt(p5_nonmir_i*p3_nonmir_i);
end
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function [win_sym_vals,win_sym_ps] = win_sym_model_list(mfes,anti_inds,model,wps)
numseqs = length(wps);
if(numseqs~=length(mfes) | numseqs~=length(anti_inds))
    error('number of seqs differs from length(wps)');
end
% transform wps into cell if it is not so.
if(~iscell(wps))
    for i=1:numseqs
        tt{i} = wps(i);
    end
    wps = tt;
end
beta = 0.5;
win_len = model.ds_win_len;
win_sym = [];
for i=1:numseqs
    wp_list = wps{i};
    mfe = mfes{i};
    ai = anti_inds{i};
    is_paired = (ai~=0);
    for k=1:length(wp_list)
        wp = wp_list(k);
        pos3_on_arm5 = mfe(wp,1);
        pos5_on_arm3 = mfe(wp,2);
        pos5_on_arm5 = max(1,pos3_on_arm5-win_len+1);
        pos3_on_arm3 = min(length(ai),pos5_on_arm3+win_len-1);
        numunpaired5 = sum(~is_paired(pos5_on_arm5:pos3_on_arm5));
    end
end

```

```
    numunpaired3 = sum(~is_paired(pos5_on_arm3:pos3_on_arm3));  
    win_sym = [win_sym,abs(numunpaired5-numunpaired3)];  
end  
end  
win_sym_vals = 0:model.win_num_bins_sym-1;  
n = hist(win_sym,win_sym_vals);  
n = n+beta;  
win_sym_ps = n/sum(n);  
%figure;bar(win_sym_vals,win_sym_ps);title('win sym training');
```